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ECONOMIC GEOGRAPHY

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APRIL

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William R. Mead

LAND TENURE IN THE LEADING TYPES OF FARMING OF PUERTO RICO
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UNITED STATES SOYBEAN INDUSTRY
George H. Primmer

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GRANITE

GOOD granite stonework has withstood the ravages of time—flame and mould and flood—better than most of man's materials. When man built of granite his cairn or barrow, his altar or temple, his home or hostelry, a bridge or breakwater, he builded for the centuries, not for his own temporal comfort or his ease. Some of the most enduring records of his long struggle up out of the pit of poverty and savagery are writ in granite, not in words but in deeds. Some of the finest interpretations of his early thoughts, his primeval ideas, have come from the form, or the fashion, or the very magnitude of the granite structures he has set along the ways of his march toward civilization.

The age of steel and concrete are a far cry from the stone age in time and in culture, but they both represent man's striving for permanence, for security, for harmony and unity in purpose and achievement. The concrete skyscraper that rises high above the harbor in today's vast intercourse of the peoples, no more represents the coöperation of many men, of mind and matter, or the combined strength and purpose of multitudes engaged in one enterprise, than does the megalithic circle at Stonehenge. Always durable stonework has engaged the toil and thought of hosts of men working shoulder to shoulder under the goad of whip or starvation, even as today in the quarry, on the highway, at the structure they coöperate under lighter spurs.

In our own land and day the competition between metal and mixed mortar on the one side, and timber and stone on the other, has waxed exceeding keen, but surely and relentlessly the latter materials are losing ground except in definite limited fields where concrete and steel may not enter, just as the former are being shaped to more and more uses, replacing the granite and marble, the oak and pine, with which our progenitors wrought and built. Even granite, the wellnigh indestructible building material through the long periods of history, is losing its popularity, and now marks less the dwellings of the quick than the resting places of the dead.

ECONOMIC GEOGRAPHY

VOL. 15 APRIL, 1939 No. 2

THE PORT OF BRISTOL

F. Walker

THE port of Bristol shares with the city to which it belongs a most distinctive admixture of important modern developments and the legacies of a very long history, and it is only in the light of these two aspects of its character that Bristol life and trade can be fully understood.

In certain respects Bristol is an entirely modern port, since its present dock system and its organization under municipal control are both the products of the last hundred and forty years, while in addition much of the equipment of the port has been provided during the present century. Moreover it will be seen later that even the port's trade has a distinctly modern flavor, and though a long and growing list of commodities is handled, the port derives much of its prosperity from trading in a small group of goods whose importance in British commerce has grown enormously during the last thirty years.

On the other hand it is equally true to say that Bristol is one of the oldest ports in the British Isles, and whereas the early history of shipping on the Avon will not be discussed, it is nevertheless one of the objects of the present paper to show that Bristol's varying fortunes during previous centuries have not been without their effect on the present character of the export.

From this point of view the most important circumstance in the earlier history of the Port of Bristol was the lack of progress which was made before the nineteenth century in improving the facilities for shipping on the Avon. It is true that as early as 1247 a harbor trench had been excavated on the site of the present Broad Quay (Figure 1) and that the construction of a stone bridge shortly afterwards prevented vessels from proceeding farther upstream and thus tended to concentrate the trade of the river on Bristol, but from this time onward no major works were carried out until the beginning of the nineteenth century. Thus, until little more than a hundred years ago Bristol's trade was entirely dependent on the unimproved navigation of a narrow and tortuous river, which had extensive mud banks and a tidal range that left vessels high and dry at the quays at low tide, but it should be remembered that these disadvantages only began to prejudice the prosperity of the port with the increasing size of vessels after the seventeenth century, and indeed, throughout most of this period Bristol's trade was second only to that of London and it was only surpassed by the growing trade of Liverpool during the second half of the eighteenth century.

During the fourteenth, fifteenth, and sixteenth centuries Bristol's prosperity was largely based on its trade with Ireland, Europe, and the Near East, but in the following centuries it gained fresh

impetus from extensive intercourse with the newly established settlements in America and from its share in the slave-trade triangle between West Africa, England, America, and the West Indies, and it should not be forgotten that from the point of view of England as a whole this small port of the seventeenth and eighteenth centuries was of far greater relative importance than is the prosperous port of today. Moreover there grew up in this period the import of wine, skins, and hides from the continent and from Ireland, of cocoa from West Africa, and of sugar and tobacco from America and the West Indies, and it should be remembered that all of these commodities are important elements in the present-day trade of Bristol and have formed the basis of the local leather, chocolate, and tobacco industries.

Nevertheless the whole of this period of relative prosperity produced no more than minor additions to the quay space on the river-side and the construction of two small docks, one near the Broad Quay and the other at Sea Mills, though what is even more significant is the fact that these works were undertaken by the Society of Merchant Venturers and by private bodies rather than by the city itself. During the fourteenth and fifteenth centuries Bristol had fallen behind in competition with London and in addition a great deal of the shipping on the Avon had passed into the hands of "strangers" so that one of the chief reasons for the granting of a charter to the Society of Merchant Venturers in 1552 was its attempt to control the growing influence of these "strangers" and thus arrest the "decay" of the port. Later, however, the Society's activities came to include the execution of minor improvements on the quays and wharves of the port, in return for which the city authorities were willing to lease the valuable wharfage, cannage, plankage, and anchorage dues to the Society for long periods and at a very low rental. In this way the city's unwillingness to undertake even minor harbor improvements meant that a valuable source of revenue was lost and there opened a phase in the history of the port in which initiative only came from bodies other than the Corporation and the control of the port consequently became less and less municipal in character.

Of the improvements carried out by private individuals and companies the only ones which call for special mention are the construction in the early seventeenth century of the so-called Merchants' "dock" in the city and the provision of the wet dock at Sea Mills in the early eighteenth century. The latter fell into disuse before the end of the century, probably because of its remoteness from the established trading center in Bristol, but the existence of such a scheme is of great interest in so far as it indicates an appreciation of the need for wet docks to overcome the problem of the tidal range of the river and coincides with a period of considerable dock-building activity at Liverpool, though in Bristol this method of harbor improvement was not adopted until nearly a century later.

By the middle of the eighteenth century, however, it was becoming apparent that some really comprehensive policy of dock construction was absolutely essential, and the history of the port in the second half of the century is largely the story of fruitless attempts to persuade the corporation to provide wet docks or to "float" a section of the river so that vessels would no longer be damaged by grounding at low tide or shipping immobilized by the lack of water at neap tides. Thus it was not until 1802 that the latter policy was finally adopted, and the following seven years were spent in carrying out a scheme

which involved the excavation of a new channel for the Avon from Totterdown to the Cumberland Basin (the New Cut), the old course of the river being turned into one large wet dock or floating harbor with access to the new course of the river at Cumberland Basin, Bathurst Basin, and Totterdown Lock (see Figure 1). In addition a further "cut" was made from Totterdown to Netham which was known as the Feeder Canal because of its function in supplying the new floating harbor with water, while the feeder canal itself was rendered navigable so that small vessels using the floating harbor or the new cut might proceed directly upstream (see Figure 1).

It was characteristic of this stage of Bristol's history however, that the belated execution of these major improvements was allowed to pass into the hands of a private company and in consequence the advantages of the new accommodation were largely offset by difficulties with the Dock Company which were not removed until the docks were purchased by the Corporation in 1848. In the first place the cost of the harbor works had been considerably heavier than was anticipated and the Dock Company was faced with the necessity of making very heavy charges in order to pay the interest on its capital, while in addition certain heavy dues still remained payable to the city and to the Society of Merchant Venturers, so that in 1823 the total port costs at Bristol were more than twice as heavy as those at London or at Liverpool. Repeated attempts to find a remedy for this unfortunate state of affairs were made by the newly-formed Chamber of Commerce but they only met with very

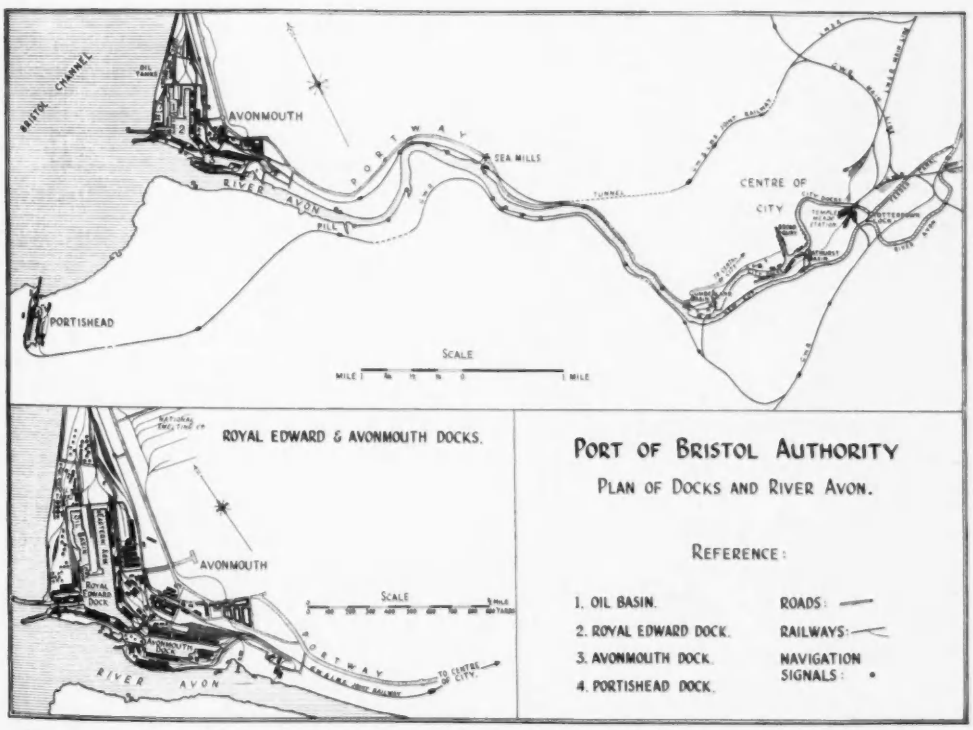

FIGURE 1.—Port of Bristol, which shares with the city to which it belongs a most distinctive admixture of important modern developments and the legacies of a very long history. (Courtesy of Port of Bristol Authority.)

minor successes and no substantial reduction in charges was made until the Corporation purchased the dock estate in 1848, after two years of intense agitation by the Free Port Association.

Even then the disputes about excessive charges dragged on for many years and in addition it soon became apparent that the Corporation was doing nothing to remove the second cause of discontent which had arisen from the unwillingness of the Dock Company to provide accommodation for the increasingly large vessels of this period. Already the Bristol-built "Great Western" and "Great Britain" had been transferred to Liverpool because of the difficulty of bringing such large vessels up the Avon to the Bristol docks and in 1851 attention was once more drawn to the need for action by the stranding of the "Demerara" on her maiden trip down the river. Nevertheless it was not until 1865 that the Corporation commenced work on a scheme to improve the navigation of the river and thus brought to an end a period of fourteen years during which the rival merits of river improvement, the dockization of the whole of the lower part of the river and the provision of river-mouth docks had been frequently debated.

The completion of these extensive harbor improvements in 1873 brought about some revival in the trade of the port, but by this time Liverpool had usurped Bristol's position as the second port in the country and there can be no doubt that this situation was due in some measure to the earlier development of dock facilities and the lower charges on shipping at Liverpool. On the other hand it should be remembered that there was actually an increase in the volume of trade at Bristol throughout this period and the "decay" of the port in the late eighteenth century was therefore a purely relative matter, occasioned by the phenomenal growth of Liverpool. Moreover this growth did not come about entirely at the expense of Bristol, since it was largely a product of the movements of industry and population associated with the Industrial Revolution. Naturally the industrial development of the coalfields of Northern England enhanced the importance of Liverpool's hinterland enormously, whereas Bristol's geographical position did not make it a suitable port for handling the raw materials and manufactured articles of the new industrial areas which formed the basis of the great expansion of British overseas trade during the late eighteenth and nineteenth centuries, though it may be emphasized once again that throughout this period Bristol made slow but steady progress.

Long before the Corporation's scheme had been completed, however, it became apparent that the provision of new docks was an absolute necessity if the port was to attract the trade of the increasingly large ocean-going vessels of this period, but once again the city repeated the mistake which it had made when the floating harbor was constructed and allowed private companies to carry out these essential improvements, so that multiplicity of control was re-established and the Corporation's dock estate subjected to severe competition. Thus, as early as 1862 a company had obtained permission to construct a river-mouth pier at Avonmouth and to link it with the City Docks by railway and in the following year a similar railway and pier scheme was approved for Portishead. It was obvious, however, that neither of these proposals would materially improve the facilities of the port unless the piers were supplemented by large ocean docks, and in 1862 such a development was suggested for Avonmouth, though

the scheme was not actually authorized until two years later and even then a financial crisis delayed operations so that the actual work of constructing the dock only commenced in 1868. Two years later a dock scheme was adopted in connection with the recently completed railway and pier at Portishead, but for a variety of reasons both of these docks took nine years to complete and they were not opened until 1877 and 1879 respectively.

It was clear from the outset, however, that the construction of the river-mouth docks would seriously affect the trade of the Corporation's dock estate in the city, since in two years Avonmouth alone had absorbed 30 per cent of the total tonnage of the port, and it was suggested almost immediately that the Corporation should purchase the rival docks, though alternative schemes for the dockization of the river found many supporters and it was therefore only in 1884 that the purchase of the outports was finally decided upon. In the case of Avonmouth the dock had been built by an independent company, but the dock at Portishead was the property of the railway and pier company and the question of the disposal of the railway line had therefore to be settled. The immediate difficulty was overcome, however, when the Great Western main line company undertook to purchase the railway, but they naturally insisted on an agreement being reached that the dock at Portishead would be maintained and worked, and in consequence the Corporation's policy with regard to Portishead was redetermined, though the railway company has been willing to coöperate in the much greater developments at Avonmouth.

Immediately after the purchase of the river-mouth docks in 1884 ambitious proposals were made for improving the river navigation to the city docks and providing railway sidings, warehouses, granaries, and other harbor equipment, but it was not until 1897 that these works were sanctioned and in the meantime it had become apparent that apart from these improvements in the existing works some further scheme of port extension was necessary. The construction of new docks at Avonmouth or at Portishead, the dockization of the whole of the Avon, and the provision of an ocean pier were all suggested as possible solutions, but towards the end of the century the rapid development of trade at Avonmouth and the continued increase in the size of vessels made it clear that the first proposal was the most valuable. Accordingly a bill was passed in 1901 sanctioning the construction of a new dock in Avonmouth and in 1908 the main portion of the Royal Edward Dock and part of its western arm was opened (Figure 1), while in the meantime the river improvements had been carried out and railway and storage accommodation greatly extended so that between 1897 and 1908 over 3½ million pounds were spent in developing the port.

TABLE I

PERCENTAGE OF TOTAL TRADE

Year	*1894–95*	*1898–99*
City Docks	73.9	60.0
Avonmouth	21.1	35.0
Portishead	5.0	5.0

Since 1908 the Royal Edward Dock has been extended still farther by the completion of the western arm and the construction of the parallel eastern arm, and at the same time the value of the Avonmouth dock estate as a whole has been greatly enhanced by the construction of a new low-level road, known as the Portway, which links Avonmouth with the city. Finally, it may be men-

tioned that the policy of the port authority during the last thirty years has been consistently aimed at providing organization and equipment adapted to the needs of the highly specialized trade of the port in such commodities as grain, petroleum, fruit, and refrigerated produce, though the actual additions to the machinery and buildings of the port can best be discussed when the methods of handling each of these cargoes are considered.

Thus in a sketch of the evolution of the Port of Bristol we may perhaps detect two general tendencies which have characterized the whole of its history prior to the beginning of the present century. The first of these was the apparent "decay" of Bristol's trade and the slowness of the responsible authorities in developing the facilities of the port, and from the point of view of present-day conditions this is perhaps the most important aspect of the whole history of the port. In the first place it has meant that the recent stagnation in world trade has had comparatively little effect on the commerce of Bristol, since the chief result of the depression has been a reduction in those branches of British overseas trade which expanded most rapidly in the eighteenth and nineteenth centuries and in which Bristol took very little part, because of its backwardness at that time and its geographical remoteness from the industrial areas with which the expanding trade was mainly connected. Instead Bristol's commerce has been based, of necessity, on an import trade in foodstuffs and general commodities which can never enjoy a true "boom" period but which has had the great advantage of being largely independent of the state of general world trade. In the second place the lateness of the port's development has meant that it is not hampered by obsolete equipment and it will be seen later that the layout of the docks and the recent additions to the shore plant have been admirably adapted to the needs of every branch of the present-day trade of the port.

The second main tendency which has been noted throughout the history of the port has been towards an admixture of control by the municipality and by private bodies and it should be noted that early municipal influence has undoubtedly been responsible for much of the delay in the development of the port, since it brought the policy of the port authority within the sphere of city politics. On the other hand excessive charges in the early nineteenth century and later uneconomic competition were both associated with control by non-municipal bodies and it should not be forgotten that private enterprise was also responsible for the existence of three separate dock systems in the City, at Avonmouth and at Portishead, an arrangement which would scarcely have arisen under unified municipal control.

Turning now to the character of the trade of the port in recent years it is

TABLE II

Year	*Imports (tons)*			*Exports (tons)*		
	Foreign	*Coastwise*	*Total*	*Foreign*	*Coastwise*	*Total*
1908–09	1,421,653	877,019	2,298,672	244,960	396,678	641,638
1913–14	1,839,052	1,131,358	2,970,410	316,505	472,182	788,687
1928–29	2,089,468	1,034,649	3,124,117	219,239	323,085	542,324
1934–35	2,428,201	938,892	3,367,093	42,474	540,467	582,941
1935–36	2,703,069	983,195	3,686,264	50,497	575,132	625,629
1936–37	2,844,873	1,034,966	3,879,839	55,680	558,478	614,158
1937–38	2,967,774	1,171,385	4,139,159	66,029	605,566	671,595

at once apparent from Table II that Bristol is predominantly concerned with imports, so that last year imports represented 86 per cent and exports 14 per cent of Bristol's trade, while if foreign trade alone is considered, imports represented 97.8 per cent and exports only 2.2 per cent of the total. Moreover it is clear that in the foreign section of the trade of the port this disparity has increased somewhat in recent years. Foreign imports on the one hand have suffered no setback whatever during the depression, since the demand for foreign foodstuffs, petroleum, wood, and certain luxury goods has actually increased in this period, but on the other hand there has been an enormous reduction in foreign exports since 1929. This reduction is to be explained chiefly on the grounds of the general stagnation of world trade, though certain special causes of a local decline will be noted later, and it is therefore a fortunate circumstance for the port that its prosperity before the depression was not really dependent on its export trade. The depression has had a totally different effect on the coastwise trade of the port, however, since the export section of this trade is mainly concerned with the redistribution of foreign imports and has therefore shown no real decrease in recent times. The coastwise import trade on the other hand is more general in character and did suffer a slight setback during the worst years of the depression, which has been ag-

FIGURE 2.—Entrance to the city docks. For many decades inadequate dock facilities, and competition and conflict between dock owners and dock authorities retarded the development of Bristol Port. (Courtesy of the Port of Bristol Authority.)

gravated to a certain extent by competition from road transport.

Besides being essentially an import center, Bristol is also remarkable in that it handles only a limited range of commodities on a large scale and if we consider next Table III, which shows Bristol's principal imports, the exceptional degree of specialization in foodstuffs, timber, and petroleum products becomes immediately obvious. Foodstuffs represented almost half the total tonnage involved in 1937–38 and of this, over 70 per cent was made up of grain and grain products, while petroleum and wood account for a further third of Bristol's total imports.

TABLE III

1937–38 IMPORTS (TONS)

Foodstuffs:		
Grain and Oilseeds	998,794	
Feeding stuffs for animals	162,566	
Fruit	108,708	
Other foodstuffs	119,049	
Total of all foodstuffs		1,389,117
Petroleum products		905,675
Wood and timber		162,094
Wood pulp		104,111
Other goods		406,776
Total imports		2,976,773

As well as being responsible for the present prosperity of Bristol, this specialization on the import of a limited number of consumption commodities has made it practicable to provide an elaborate plant and a special layout for handling each type of cargo, though it should be remembered also that this could only be done in a port which was not already fully provided with old equipment.

The trade in grain (which increased from 582,347 tons in 1909 to 1,001,768 tons in 1936–37) is, of course, of vital importance to Bristol and the share of the port in the total trade of the United Kingdom is shown in Table IV which also shows the relative importance of each of the four most common grains. The large proportion of barley in the first column is interesting in that it is particularly appropriate to a west country port where the climate is unsuitable for the local production of this grain, but it should be noted that in recent times barley has tended to be replaced by the use of ground maize (which is cheaper) and this grain is now imported in greater quantities than barley. Naturally the proportion of grain which comes from different countries varies from year to year, but the general position can be seen in Table V.

TABLE IV

GRAIN IMPORTS, 1937–38

Grain	*Percentage of Total Imports into United Kingdom*	*Percentage of Total Grain Imports at Bristol*
Barley	20.2	21.0
Maize	10.5	39.0
Oats	8.9	0.5
Wheat	7.6	39.0
Other grains	....	0.5

TABLE V

GRAIN IMPORTS

Origin	*Percentage of Total Tonnage*		
	1935–36	*1936–37*	*1937–38*
South America	45.2	44.1	38.1
Canada	21.9	25.8	20.7
Asia	6.7	12.5	15.3
Europe	18.9	10.7	9.1
Australia	5.5	5.7	8.9
New Zealand			
United States	1.8	1.2	7.9

A highly efficient method of handling the grain cargoes has now been evolved and this centers about the use of a carefully laid out transit granary into which the grain is rapidly delivered from the ship by land and floating plant of the pneumatic and bucket types, the floating plant also discharging into barges

(to accelerate the turn-round of the ship) which are later unloaded at a special berth or towed up the Avon or the Severn or across to South Wales. Ex-ship deliveries of grain into road and rail containers (many of them of the hopper type) can be made from the transit granary itself but the ship need not be delayed by the lack of land transport, since the surplus grain is represent nearly 60 per cent of the total quantity involved.

Fruit imports are of necessity handled in a variety of ways and the factors involved in the use of particular docks for the different varieties of fruit will be discussed later, but it may be pointed out here that bananas represent more than 70 per cent of the total fruit imports at Bristol and specialized plant has

FIGURE 3.—Avonmouth dock estate. This dock was built by an independent company, while the dock on Portishead was the property of a railway and pier company. (Courtesy of the Port of Bristol Authority.)

stored in the silos of the transit granary and later moved by conveyor bands to the storage granaries. In this way the interests of the shipowners in a rapid turn-round and the interests of the merchants in the availability of ex-ship deliveries are both served. Finally it may be mentioned that among the feeding stuffs for animals, which are mentioned in Table III, cereal by-products occupy an important place, since they

therefore been evolved for this particular trade. The first cargo of bananas arrived at Avonmouth in 1901 and so rapid has been the progress that over 6,000,000 bunches are now imported annually, representing more than one-fourth of the total imports of the country. The trade is mainly with the West Indies and Central America and has been developed by Messrs. Elders and Fyffes Ltd., who operate a large fleet

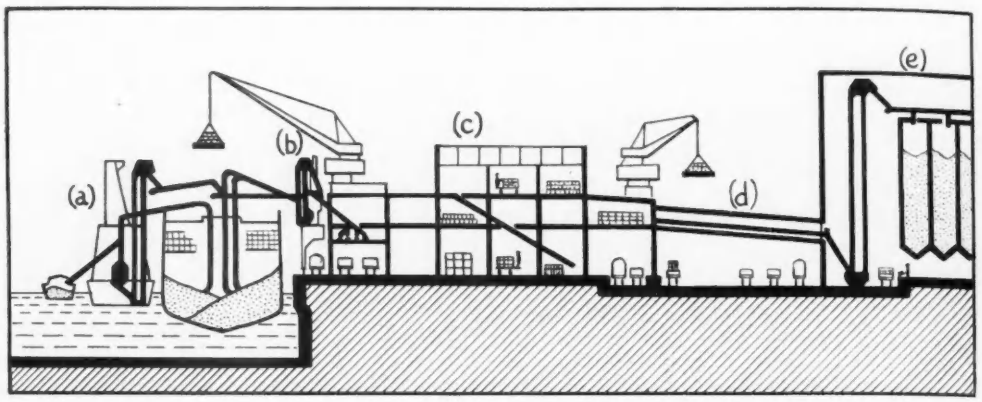

FIGURE 4.—Cross section of "U" shed, Royal Edward Dock, showing discharge and delivery of grain and general cargo. (a and b) floating and land plant, pneumatic; (c) transit shed with cranes for general cargo and loading platforms for road and rail; (d) overhead conveyor gallery for grain; (e) storage granary. (Courtesy of the Port of Bristol Authority.)

of modern vessels and who coöperated with the port authority in 1923 in building at Avonmouth a type of electric elevator suitable for handling this highly specialized cargo and delivering the bunches to the railway loading platform which forms part of a circulatory marshalling system allowing a continuous movement and supply of empty vans.

Of the "other foodstuffs" only the group which is classified as "provisions" (butter, cheese, lard, meats, etc.) requires special equipment because of the fact that most of these goods are transported and stored in a chilled or frozen condition. The general scheme of handling these cargoes resembles that employed for grain, since the goods are first transferred to a transit and sorting shed where immediate delivery to insulated road and rail containers is available (see Figure 7), the remaining produce being carried by overhead galleries to a large and elaborately equipped cold storage which corresponds to the storage granary mentioned above. The two most important items are butter (12,144 tons in 1937–38) and frozen meat (14,287 tons in 1937–38) and though the nature of this traffic has made fluctuations in volume almost inevitable, it seems probable that still further expansion will take place in this trade, which is mainly carried on with Australia and New Zealand.

Petroleum products form fully half of Bristol's remaining imports and accordingly the port authority has provided unequalled facilities for the unloading of tankers. During the last twenty years vessels of this type have tended to become increasingly large and costly and shipowners naturally preferred to avoid berthing them at the exposed jetties which were usually allocated by harbor authorities for the handling of inflammable cargoes, so that the present prosperity of this section of the trade of the Port of Bristol is due in no small measure to the fact that this was one of the first ports to permit the unloading of vessels with petroleum spirit in an enclosed dock. This was made possible by the layout of the Royal Edward Dock which permitted of the conversion of the whole of the western arm into an oil basin, isolated as a precaution against fire by an electrically operated safety boom. In addition plenty of land space was available for the safe disposition of the large number of storage tanks which now form such a distinctive feature of

FIGURE 5.—Transit granary, Royal Edward Dock. Note facilities for road and rail transport and overhead galleries to the storage granary. (Courtesy of the Port of Bristol Authority.)

the landscape at Avonmouth. Thus the annual imports of petroleum have increased from 75,000 tons in 1902 to over 905,000 tons during 1938, and the relationship of this trade to the rapid development of the internal combustion engine has meant that it has not been affected by the general decline of trade in recent times and it has therefore combined with the increasing imports of foodstuffs to make Bristol one of the most prosperous ports in the country.

Timber ranks next in the list of imports but little need be said about it at this point, since the universal demand for woodwork results in timber appearing on the import list of almost every port. It may be mentioned, however, that there are well equipped timber yards at each of the Bristol docks and that the great activity in the building trade in the last few years has been responsible for an increase in the volume of these imports.

The most interesting feature of the list of "other imports" is the presence of a group of commodities of a less modern kind, which may be termed "traditional imports" since they are to be related to the former trade of the port and are maintained, partly because of long usage and partly because of the fact that the industrial and distributional organizations for handling them have grown up and become firmly established in the Bristol region. Thus Bristol's share in the early trade with America is reflected in her imports of tobacco and her former connections with the slave-trade triangle in her imports of cocoa and sugar, while the present trade in wines is not unconnected with the early fame of Bristol as a wine importing town. In more recent times, however, the maintenance and perpetuation of these old trades has been almost entirely due to the establishment of the Imperial Tobacco Company's warehouses and factories in the city, the existence of important chocolate firms like Fry's and Cadbury's within the distributive area of the port and the reputation of certain famous firms of wine dealers. Nevertheless these old-established imports now form the basis of growing luxury industries and therefore share in the general prosperity of Bristol's import trade, since they have not been greatly affected by the recent stagnation in general world commerce. No specialized equipment is needed for handling these particular imports but adequate storage space is essential and bonded warehouses have therefore been provided for each commodity, either by the port authority or by private firms.

Apart from these traditional imports, the only large entries among the "other imports" consist of zinc concentrates and pyrites for the National Smelting Company at Avonmouth and rock phosphate for the associated National Fertilizers Ltd., the ores being conveyed directly to the factories by an elaborate aerial ropeway from the quayside at the Royal Edward Dock.

In the coastwise section, Bristol's import trade is largely carried on by regular liner services and it may be

divided into two sections. The first of these is concerned with goods which are brought in ocean steamers to other ports and then transported coastwise to Bristol; the second section consists of the coastwise shipment of coal (mainly for use in the docks) and of articles manufactured in other parts of the British Isles which are then redistributed in the southwest by the numerous distributing agencies.

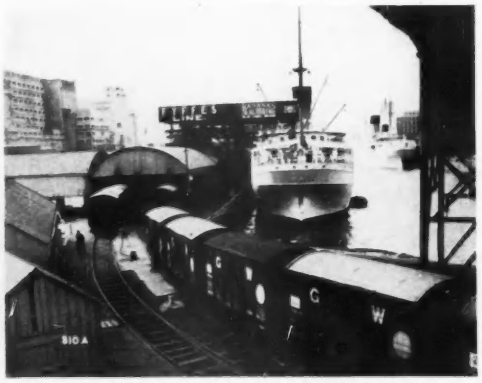

FIGURE 6.—Fyffes liner discharging bananas at Avonmouth. Note the railway layout. (Courtesy of the Port of Bristol Authority.)

This aspect of Bristol as a distributing center is particularly vital when one recalls the dominance of the import section of its trade and from this point of view Bristol's geographical position is extremely favorable since the long inlet of the Bristol Channel makes it virtually an inland port and gives it a distributive area which includes not only Southwest England and South Wales but also South Central England and a large part of the Midlands. The whole dock estate is served by both the Great Western and London, Midland, and Scottish railways, giving access to all parts of Britain, and since the construction of the Severn Tunnel direct railway communication with the industrial areas of South Wales has been greatly facilitated. Moreover, Bristol is the focus of roads to the Midlands and to South and Southwest England and the construction of the Portway has provided easy access to these roads from the docks at Avonmouth. Finally water transport is available to the Midlands by means of the Severn Navigation and canals connected with it, and to Bath and the surrounding areas by way of the upper Avon.

By reason of geographical proximity the southwestern counties tend to absorb the greatest proportion of Bristol's imports, though an additional reason is to be found in the need for grains and feeding stuffs in agricultural counties like Devonshire, Wiltshire, and Somerset which specialize in animal husbandry. The densely peopled areas of the Midlands come next in importance, while the south of England and South Wales are of rather less importance, though these generalizations do not necessarily apply to particular commodities, and specialized cargoes like bananas naturally tend to have a much wider distribution than cargoes like timber, for example, which is handled at almost every port.

It might well be expected that this extensive hinterland would have led to the development of a large export trade at Bristol, but it will be recalled that this is far from the case and it is necessary to discover the reasons for this remarkable situation. In the first place Southwest England is not a highly industrialized area and articles for export are therefore not numerous, while in the immediate vicinity of Bristol itself most of the industries are concerned with the production of goods for the home market (tobacco, leather goods, paper, etc.) and not with large-scale manufactures for export. The industrial areas of the Midlands, however, would seem to form a natural source of cargoes for the Bristol docks and indeed at the present time there is no reason

why a much larger proportion of these exports should not pass through Bristol, since facilities for handling all kinds of cargoes are available and the port authority is making great efforts to improve this side of the trade of the port. It should not be forgotten, however, that in the Midlands Bristol has had to compete with other ports, and it has to be remembered also that when the industries of the Midlands were developing most rapidly during the late eighteenth and nineteenth centuries Bristol was still a very backward and above all a very expensive port, and it is possible that the lack of exports from this region in more recent times may have been due to industrial inertia.

Until ten years ago there did exist, however, a considerable export of iron and tinplate from local works and from South Wales, in boats which unloaded part of their cargo at Bristol and part elsewhere, and then returned to Bristol to load this heavy metal cargo at the bottom of the holds before picking up a lighter general cargo at Liverpool. The transfer of the local works to Newport, however, and the later development of works in Australia has meant that much of this trade has disappeared, and in any case the South Wales ports are now capable of handling all the local exports, so that few vessels now return to Bristol after their initial call to unload. Thus, if we consider these facts in conjunction with the depressed state of world trade in general it is not surprising that Bristol's foreign exports declined from 316,505 tons in 1913–14 to 66,029 tons in 1937-38.

On the other hand the coastwise exports from Bristol have increased steadily from 472,182 tons in 1913–14 to 605,566 tons in 1937–38 and the reason for this difference is obvious if we consider the two categories into which this coastwise trade can be divided. In the first place the regular coastal liners take return cargoes of local products to other parts of the British Isles for home consumption and this section of the trade of the port is therefore not seriously affected by the state of international trade, while the "tramp" section of the coastwise trade is mainly concerned with the redistribution of Bristol's increasing overseas imports and is correspondingly prosperous.

FIGURE 7.—Transit shed, connecting galleries, and the Royal Edward Cold Storage, Avonmouth. (Courtesy of the Port of Bristol Authority.)

The actual goods which are exported from Bristol to foreign ports are extremely miscellaneous in character and there is no single commodity of outstanding importance. Chemicals (mainly salt-cake) from alkali works at Netham and in the Midlands formed the largest export in 1936–37 and partly-treated ores from the works of the National Smelting Company at Avonmouth ranked second, while the only other large exports were concerned with certain special natural resources of the Bristol region such as strontia from Yate and clays from Newton Abot. These goods only represent about half of the total exports, however, and the remainder are so mixed in character that no analysis is possible, but it may be mentioned in conclusion that iron,

FIGURE 8.—Tankers in the oil-basin, Royal Edward Dock. Electrically operated safety boom in the foreground. (Courtesy of the Port of Bristol Authority.)

steel, and tinplate now only play a very small part indeed in the export trade.

Within the port itself trade is unevenly divided between the three dock systems (see Table VI) and the cause of this position can best be appreciated by consideration of the way in which individual cargoes tend to be handled at particular docks.

TABLE VI

Docks	*Total Trade in 1937–38 (Tons)*
Avonmouth	3,239,609
City	1,293,159
Portishead	277,986

The trade in grain, feeding stuffs, and oilseeds is now carried on in very large ocean-going vessels and for this reason it has naturally tended to center in Avonmouth, though before the war the City docks and Avonmouth shared this trade in almost equal proportions. In recent years, however, the dominance of Avonmouth has become complete and has been rendered permanent by the establishment of the special grain-handling plant at Avonmouth, though it is interesting to notice that a considerable amount of flour and some grain is actually brought to the City docks from America and Canada by vessels of the Bristol City Line which have been specially constructed for navigation of the Avon. Nevertheless for all practical purposes the grain trade has been confined to Avonmouth and it may be noted in addition that there has been a further division of function between the two docks in this area, the old Avonmouth dock concentrating on the handling of grain which is to be milled at the dockside, while the Royal Edward Dock specializes in the reception of "Merchant grain" which is to be stored and transported to mills farther inland (except for the grain which is milled by the Co-operative Society on the dock estate).

For almost identical reasons the trade in provisions is also handled by the plant and cold storage at Avonmouth and only 8 per cent is taken direct to the City docks, while the import of petroleum is naturally confined to the oil-basin in the Royal Edward Dock and little more than one per cent is landed at Portishead.

The imports of fruit are more evenly divided between the City docks and Avonmouth, but in this case there is an interesting distinction between the different varieties of fruit according to their place of origin. Bananas from the West Indies, apples and dried fruits from the Dominions and California, and canned fruit from the west coast of America are all brought in large vessels and are therefore normally landed at Avonmouth, but oranges, lemons, raisins, currants, and green fruits which originate in the Mediterranean are brought in vessels which can easily proceed to the City docks, where they are conveniently close to the salesrooms. Similarly in the timber trade there is a definite specialization on certain types of wood at each of the docks. Avonmouth has naturally specialized in the hardwood trade, since this class of timber has normally to be carried long distances in ocean-going vessels, but a

much larger part of the timber imports is composed of softwoods which frequently arrive in quite small North European boats and this trade is therefore shared by the City docks and Portishead, though the volume of trade at the latter dock has been disappointing.

The coastwise section of the import trade is shared by the various docks in proportions shown in Table VII, but

TABLE VII

COASTWISE IMPORTS, 1937–38

Avonmouth	*City Docks*	*Portishead*
17%	63%	20%

at Avonmouth and Portishead cargoes consist almost entirely of coal and certain other minerals, so that it is only at the City docks that a more general coastwise import trade exists. This great concentration on the City docks is undoubtedly due to the convenient proximity of the warehouses of the distributing firms and the factories of the manufacturing firms, but in addition the smallness of the vessels in the coastwise trade is an important contributory factor.

Finally it is interesting to note that Bristol's small export trade is very largely concentrated in the city. In the foreign section of this trade actually 65 per cent of the total tonnage is handled at the City docks and the reason is undoubtedly to be found in the fact that a very large proportion of this branch of the port's commerce is carried on with European countries. Under these circumstances it is obvious that the City docks are best suited to the traffic since it has already been pointed out that European imports such as fruit and timber tend to arrive in small vessels which can proceed directly to the City docks and which are therefore available for outward cargoes. In the coastwise trade on the other hand it is true that 80 per cent of the exports are made from Avonmouth since they are mainly concerned with the redistribution of imports such as grain and petroleum, but if the true exports (as distinct from re-exports) are considered it will be seen that the City is again preëminent. This is chiefly due to the fact that the docks are near to the warehouses of the local manufacturing firms whose goods form the basis of this trade, and this is also a contributory factor in the location of the foreign export trade at these docks.

There is, therefore, an interesting division of function between the City docks and Avonmouth, but it is quite apparent, on the other hand, that Portishead plays a very small part indeed in the general trade of the port and only handles 6 per cent of its total tonnage. It is true that this is due in no small measure to the deliberate development of Avonmouth, but in any case a comparable development of Portishead would have been rendered very difficult by the hilly nature of the surrounding country, by the absence of good roads, and by the difficulty of access to the dockside for road vehicles. Nevertheless this third dock was very useful in the period immediately before the construction of the Royal Edward Dock and during the war and it is perhaps best to regard it as a reserve dock, though the building of the Bristol Corporation power station on the dockside has necessitated large coal imports and this does give the dock a definite function and compensates in some small measure for the lack of timber and grain imports for which it is equipped.

Thus we may summarize the trade of the Port of Bristol by saying that its present prosperity is very largely based

on imports of foodstuffs, petroleum, and certain "luxury" articles. Indeed we may see in the Port of Bristol an illuminating comment on the modern economic geography of the British Isles and at the same time a refutation of any idea that a port cannot prosper unless its trade is balanced and the basis of its commerce is varied.

Note: The author wishes to thank the General Manager and other officials of the Port of Bristol Authority for the valuable help which they have given in the preparation of this paper and for permission to reproduce the various photographs and diagrams.

AGRICULTURE IN FINLAND

William R. Mead

PART I

FINLAND, one of the most happy and stable of the post-war creations of Europe, lies at the northeast corner of the continent, midway between the Scandinavian backbone and the Russian plain. Its southern shores are washed by the Baltic Sea and northward it pushes a tongue of land to the rim of the Arctic Ocean. The country, situated between 60 and 70 degrees North Latitude, is among the most northerly states of the world and its regional location accords to it a place within the broad vegetational girdle of the coniferous forests. In size, Finland is somewhat larger than the British Isles and from the comparative viewpoint no other country possesses such a wealth of timber resources.

As a producer of timber and of timber products in the widest sense of that term, Finland has achieved a prominent position in world economy during the postwar period. On several occasions she has aspired to the level of the world's chief exporter of these commodities and the inherited skill and traditional care with which the forests are exploited guarantees their continued precedence in the future.

Yet there is, in Finland, an industry which is at once both older than forestry and closely allied to it. Agriculture is the mother industry of Finland if forestry is the chief source of the national income. The evolution of agriculture is intimately connected with the rise of forestry. Whereas, however, in the modern economy, agriculture is oriented primarily to the domestic market, the pursuit of forestry is chiefly a function of the foreign market. Nevertheless, as will be seen, both are fundamentally responsive to world conditions and if exploitation of the forests is relative to the state of the world market for the resulting produce, increasing dependence of Finland upon international exchange subjects agriculture equally to its influence.

Plant Cover

Until the modifying hand of man intervenes, the plant association of any given region is principally a response to two sets of factors: (a) edaphic conditions; and (b) climatic regime.

In Finland, the northern "taiga" provides the national response to geographic environment and the ubiquitous conifer would seem to suggest that the climatic regime has been the decisive factor in influencing the vegetative covering. With the retreat of the ice sheet, which covered Finland entirely during the glacial epoch, the country presented a "tabula rasa" upon which a new plant life was left to fight out its destiny. The resulting dominance of coniferous species from the southern fringe of islands to the northern wastes of the tundra is largely irrespective of the nature of the underlying soil. The edaphic conditions which prevail in Finland may be regarded as the result of three major influences. First, the nature of the bedrock which forms the ancient shield of the Baltic Region. Second, the effects of glaciation. Third, the subsequent influence of the climate as a modifying agent.

TERRAIN

The Baltic Shield is one of the most primitive land masses which are exposed on the earth's surface. Already in pre-glacial times the contours of the massif exhibited the outlines of a peneplain which had been levelled down since the pre-Cambrian era. As a stable block it withstood the earth movements of the Tertiary era, which did little more than fracture in certain regions its denuded surface. Furthermore its elevation above the level of the Tertiary seas resulted in a comparative absence of associated deposits. Such sedimentation as did occur during the Tertiary period was largely removed by subsequent glacial action.

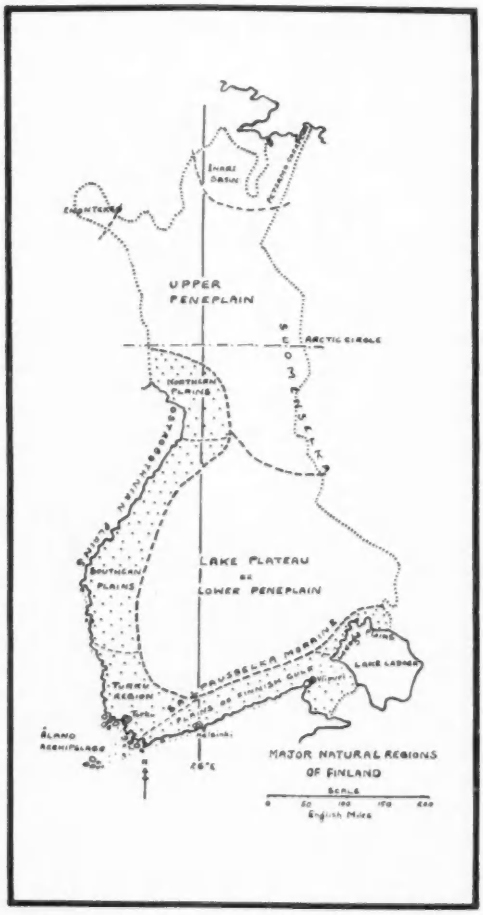

FIGURE 1.—Geographic location of Finland and the principal physiographic regions with their sub-divisions. The coastal fringe, enfolded in the two "wings" of the northern Baltic, is stippled and the Salpausselka ridge drawn in bolder outline.

The shield region is therefore an Archean complex which has long displayed its present peneplained form. The prime constituents of this complex are granites of various ages, the unconformity of which largely defies classification; metamorphosed rocks such as gneisses and schists which form the outstanding ridges or "varras" of the shield region; intrusive volcanic materials and conglomerates. The differential erosion which characterizes the components of the ancient complex results in a certain regional distribution of soil types. Yet as a result of the exceedingly slow process of weathering and the superficial covering of glacial deposits, soils directly evolved from the bedrock are comparatively rare. Disintegration is most notable on the varras and the bald tops of the rounded granite hills.

Agriculture is, naturally, not associated with these regions, although the vegetation covering shows a close adaptation. More important, perhaps, than the disintegration of the basic rocks of this "land of granite" is the configuration of the peneplain. It is characteristically a region where all positive forms of relief are rounded and surrounded by intervening hollows and shallow synclinal formations. The nature of this configuration is highly important in view of the impermeability of the bedrock. The morphology of the peneplain favored lake formation as subsequent influences played upon it. As a result of the structure of the shield modern geologists tend to divide the region into an upper peneplain and a lower peneplain. Finland as a morphological unit tends to rise from the Baltic coast like a shallow amphitheater

towards the higher land of the Balto-Arctic Divide. The greater elevation of northern Finland has encouraged the use of this appellation. (See Figure 1.)

The glacial era has been the most important geological epoch for the human agent in Finland because its effects have been paramount in producing the chief surface features of the country at the present time. As an erosive agent, the continental glacier, which emanated from the Scandinavian mountain axis, removed entirely the superficial deposits which covered large tracts of the country, denuded to a still greater extent the Archean massif and, concentrating in the zones of fracture, gouged into the bedrock. As a factor influencing deposition, the glacier has been primarily responsible for the distribution of all the quaternary deposits which are scattered over the country at the present time.

Since it is upon these deposits that agriculture is situated it may be well to consider them in greater detail. They assume a number of distinctive forms and influence agriculture indirectly as well as directly. In the first place it is necessary to remember that deposition occurred largely irrespective of the contours of the underlying peneplain and that, relatively speaking, land forms which result from deposition tend to decrease towards the north of the country. As a result the morainic material which is liberally strewn over the shield has had a pronounced effect upon the hydrographic system. The great terminal moraine of the Salpausselka, stretching from Hango in the southwest, like a great arc around the southern fringe of the country, to the Russian border, acts like a mighty dam, stemming up the waters of the interior, except where the Vuoksi and the Kymmene rivers burst through their bottle neck channels to the coast.

The sinuous oses which radiate into the lake plateau from the terminal moraine obstruct the drainage system and together with the strings of drumlins block the shallow depressions of the peneplain to form extensive lakes. The wealth of lakes which characterizes the lake plateau of Finland may be regarded as the consequence of the widespread deposition of glacial debris. Unfortunately, similar causes have produced the extensive areas of marshland which have accorded Finland its national title of Suomi.

Whereas the thousands of lakes which characterize the surface of the country are in themselves no barrier to agricultural development, the adjacent marshland exerts a negative influence. The alignment of the glacial deposits of the lake plateau along the main axis of retreat of the ice sheet (S.E.—N.W.) gives to the country the unique appearance of having been ploughed up by some giant. The ridges are crowned with forests and the furrows filled with the lake basins which drain to the southeast.

Erosive forces are today vigorously affecting the surface of the land. Throughout the country, water and land are struggling for supremacy. The youthful hydrographic system which struggles to achieve maturity is delayed in its effort to establish a developed drainage pattern by the isostatic movements which are slowly altering the relative elevation of the shield. Over the flood plains of their lower courses the rivers distribute fluvial deposits. The wealth of fluvial soils which are apparent in more mature countries have, however, no counterpart in Finland. Although rural settlement shows a concentration in proximity to the waterways, fertility of the adjacent ground is not always the conclusion to be drawn. Similarly in the lake district, youth of

the drainage pattern results in absence of those fertile lacustrine basins which vivify the agricultural life of central Sweden. The slow decline in the level of the lakes which is apparent, in so far as it does not result in an increase in the extent of marshland, will provide further scattered areas of fertility for future generations.

COASTLANDS

It is, however, the edaphic conditions of the coastlands of Finland which are of greatest interest, because it is from the shore line that settlement has penetrated inland and upon the littoral fringe of the Baltic that both the agricultural and industrial population is densest. In virtue of the geographic location of the country and the nature of its resources, concentration of urban settlement along the marine periphery is to be expected.

What factors have promoted the agricultural denseness upon the coastal plain? In the first place, the soils of the coastal plain are relatively the most fertile. Second, they are much better drained than those of the interior lake district. Third, the potential cultivable area is infinitely greater and much less obstructed by the frequent changes in contour and persistent emergence of the granite rock which typifies the interior region. Fourth, climatic influences have favored the coastal fringe at the expense of the lake hinterland, while the numerous social and purely economic factors which stimulate this concentration emerge in the main body of this consideration.

The greater fecundity of the soils of the coastal plain is to be explained by two facts. First, the present littoral of the south and southwest was, during the time of formation of the terminal moraine, a part of the glacial outwash plain upon which were deposited the laminated clays which now form the basis of the agricultural land. Second, the Ostrobothnian plain land owes its present form to oscillations in the level of the coastline which followed upon recession of the glacier. Successive negative and positive oscillations which have typified the region during post-glacial times have resulted in accumulated sediments across which rivers of the present time have intrenched wide and shallow valleys. The emergence of the coast line (at some 36 cms. per century in the west and about half this figure in the south) which characterizes the land at the present time reveals the past origin of the plains of Ostrobothnia. Marine formations are also evident as well as glacial deposits.

SOILS

The relative paucity of the soil over the greater part of Finland, which may be classed in the same podsol group as that of Northern Russia, is to be attributed first to the effects of the Ice Age and the nature of the redistributed glacial deposits; second, to the unyielding qualities of the underlying bedrock, and third, to the climatic regime. The stern and rigorous nature of the Finnish climate is a primary factor in producing the cold, grey, lifeless soils which cover such large tracts of the country.

The rich humus which adds to the fecundity of the soils in more favorably located regions is here absent. The plant covering opposes its formation. Bacteriological life is reduced by low winter temperatures. Except in favored regions, leaching has occurred to diminish productivity, while the acid soils of the marshland regions require generations of cultivation before they are of agricultural value. Both lime and phosphorus are deficient over the greater part of the country to encourage plant growth. The relative paucity of the

soils increases to the northeast, where a yet more rigorous climate intensifies the tendency towards sterility. The accompanying diagram (Figure 2) shows the most fertile agricultural regions. It is an interesting fact that Lapland, due account being taken for its climatic adversities, displays limited areas of fertility. These are to be attributed both to the presence of lime in the soil and the fluvial deposits resulting from spring floods.

Land settlement as a result of distribution of soils has revealed one important characteristic. Occupation of the land has progressed from richer areas to poorer areas of soil. Penetration into the hinterland of the coastal plains did not offer prospects which were highly encouraging, for the interior was generally more sterile than the coast. Exploitation of the soil seems to have shown a corresponding adaptation in earlier times. The customary form of winning land for cultivation until the beginning of the last century was "burn beating"—a destructive process whereby the forest covering of successive areas was reduced to ashes in order to obtain several crops. Decreasing returns was the signal for further "firing" of the land. In burn beating, settlers in the interior descended to the lowest levels of the extractive process. Contrast between settled areas of greater fertility, where soil has been enriched by generations of culture and exploitation of the land, was a positive procedure, and temporarily occupied areas of comparative sterility where cultivation was characterized by a negative process, was indeed great. Upon the principle "to him that hath shall be given," it seemed that the settled population of the coastal plain experienced a slow improvement in their better lands, while the virtually mobile population of the interior effected a further impoverishment of land which was already poor.

CLIMATIC REGIME

The climatic regime which has such a profound effect upon land utilization is determined by four principal factors. First, northerly latitudinal situation. Second, presence of the main continental rump to the east. Third, and in antithesis to the second factor, preponderant

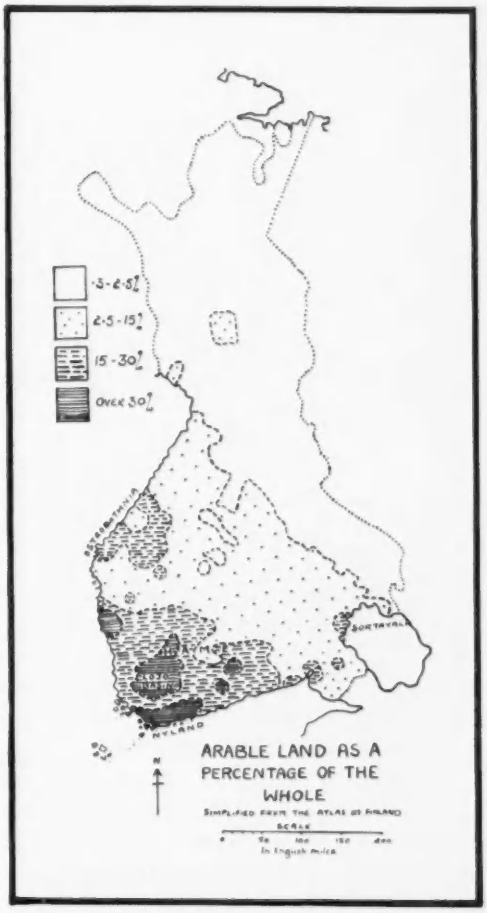

FIGURE 2.—"The finest country is this land of the north, where the field recedes before the forest, where the soil is dry, stony and sterile." So wrote Bertil Grippenberg, one of the leaders of the country's literary renaissance. In the country as a whole as it is depicted in this map, no less than in the case of the individual homestead, is to be seen the encroachment of cultivated land upon the forest, and the domination of forest away from the coast. (Simplified from the Atlas of Finland.)

maritime influences of the Atlantic to the west. Finally, superficial distribution of land and water within and around Finland itself. If the climatic regime of the upper peneplain be regarded as an independent unit, largely correlating with that of the Tundra zone proper, the rest of the country experiences many influences of a homogeneous nature, although its extent suggests four broad divisions, as in Figure 4.

FIGURE 3.—Landscape in Uusimaa (Nyland). Patches of sand and coarse grass in foreground are indicative of soil formation. The edge of the forest is always close. The nearer landscape would seem to suggest recent deforestation. The water cart to the left of the cottage is suggestive of difficulties of water supply. (Courtesy of The Finnish Legation.)

The cyclonic influence may be regarded as the dominant factor in the climate of the lower peneplain and the peripheral plains. Penetration of the succession of Atlantic eddies into the Baltic basin gives land areas adjacent to this marine inlet a climate notable for its maritime characteristics. As a result of the cyclonic system and of neighboring water masses, Finland has a very high positive thermal anomaly—only exceeded, in fact, by that of Norway.

The country has a high relative humidity which is very persistent (75 to 85 per cent), and cloudiness is characteristic of the climatic regime. The influence of the cloud cover is highly important. Exclusive of its relationship to insolation is to be mentioned the "blanket" effect which the cover produces. Its maximum extent occurs with the advent of winter and during the latter part of autumn. It is partly responsible for the temperature "lag," since loss of heat from the land by radiation is reduced to a minimum. Yet in spite of the comparatively great proportion of cloud cover, rainfall tends to be low. Given the maximum possible hours of sunshine, insolation varies inversely with the extent of the cloud cover; rainfall, however, is in no wise proportionate.

Average precipitation for the entire country is slightly over 20 inches. It is greatest in the southwest and falls to a minimum in Lapland. Otherwise distribution is fairly even and there are no great changes in the gradients in the rainfall graph for stations scattered throughout the country. As for seasonal distribution of rainfall, there is generally a winter minimum—the maximum of the summer months reflecting the transition to the continental regime. On an average there is estimated to be one wet day a week. The generally low quantum of rainfall is partially offset

by high humidity: but during the summer months deficiency is stressed by mounting temperatures. The cyclonic system introduces uncertainty into the climatic regime, since an irregularity of precipitation is to be expected. Owing to the resulting maldistribution in time, and to a lesser extent, in space, irrigation has been suggested as a corrective to possible aridity.

The crops of the coastal plain are highly dependent upon adequate precipitation during the growing season and lack of moisture has important effects upon returns. In April the drought usually attains a maximum and it is precisely at this period that increasing daylight and mounting temperatures should stimulate growth. The practice of irrigation in so northerly a latitude would not be unique, for the inhabitants in the Otta Valley in Norway pursue this method with considerable success. The location of Finland upon the fringe of the continental rump means that the thunderstorm, with its heavy convectional rain, is a feature of the summer months. The number of days with thunderstorms increases towards the southeast.

Insolation is, however, of more fundamental importance, because the course of the seasons is the product of the sun. Other things being equal, the northern latitude in which the region is situated results in pronounced changes in length of day at the summer and winter solstices. Lapland lies in that part of the world where, as Pliny says, "There is but one rising of the sun . . . and one setting." The temperature regime in Finland as a whole, largely hinges upon this fact. There is one certainty in the Finnish climate—the seasonal ebb and flow of daylight. Generally speaking, insolation attains a maximum with the maximum length of daylight, although this depends upon regional peculiarities.

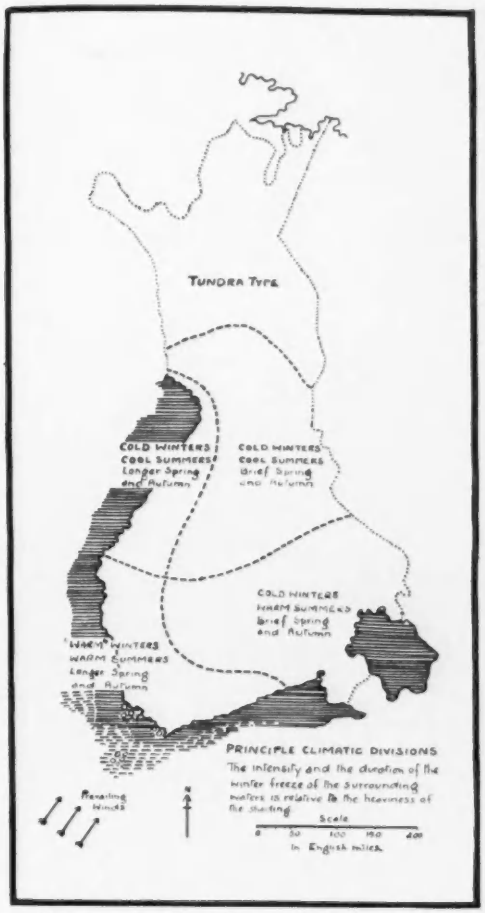

FIGURE 4.—Broadly speaking, four main climatic divisions (exclusive of the tundra zone) are defined.

It declines to an absolute minimum at the winter solstice, not merely because of the low degree of declination (cf. some 3 degrees at Helsinki), but because of the cloud cover. Helsinki has known as few as two hours of sunshine during the whole of December; although the average insolation for that month is somewhat above this figure.

Agriculture is very responsive to insolation *per se* and in the lake plateau, cultivation shows a predilection for those sunny slopes of the eskerridges which traverse the country. Temperature is a function of insolation and rises and falls upon the heels of sunshine in Fin-

land. During the summer months, the absolute length of sunshine compensates for any deficiencies in intensity and sends temperatures soaring to a height which is often tropical. There is an average of some nine hours a day in the south during the height of the summer: but in spite of continuous daylight, this figure declines to seven hours in the north. Fog and cloud are obstructive agencies in the tundra region to a greater extent than in the south during the summer

FIGURE 5.—The absolute limit of cultivation. A rye harvest upon the Arctic border—the Sallatunturi fells, already snow-capped, in the background. (Courtesy of The Finnish Legation.)

months. The corresponding average temperatures during the summer for the south and north are 63 and 60 degrees Fahrenheit respectively. It is an interesting point that the entire country experiences higher average temperature correlation than does Scotland.

There is close correlation between the isotherms of the land in proximity to the Baltic Sea and the contours of the Baltic Basin. This decreases towards the interior, while beyond the Arctic water shed the water mass of the Boreal Ocean is the decisive influence. Winter temperature conditions are in complete antithesis to those of the summer. In winter it is the continental influence which reigns supreme. The Finnish lakes freeze and the fresh waters of the northern reaches of the Baltic also submit to the ice. Instead of the liberal distribution of water surrounding the country and occupying the lake plateau, the entire region becomes a virtually continuous land mass, made a homogeneous whole by the winter freeze. In precisely the same way as the cumulative influence of the summer sun raises temperatures to a maximum, so now the persistent frost intensifies the cold. The northern interior, where a mercury freeze is experienced, becomes dominated by a minor pole of cold. Paradoxically enough it is the Petsamo fringe of the Arctic coast which often records the highest temperatures in the depths of winter; the ice-free waters of the ocean resulting in a compression of contours on the winter isotherm map.

The winter fall in temperatures results in snowfall as the accompanying form of precipitation. Some 35 to 40 per cent of the annual precipitation occurs as snow. This, it must be noted, is some 6 to 7 inches; a figure which is markedly low. The snow cover is of vital conse-

quence both for Finnish agriculture, as such, and for the national industry of forestry. The persistence of the snow cover is therefore the *sine qua non* of a "good winter." This is only ensured by the continuance of low winter temperatures. The advent of a cyclonic disturbance in the south during the winter season is therefore viewed with as great dread as the summer frosts. Under normal conditions, the snow cover remains for some 130 days in the south and attains an average depth of approximately 18 inches. The north averages 200 days of snow cover and the thickness deepens to 40 inches.

These more general considerations define the average conditions which characterize the climate of Finland. They give, however, relatively little insight into the actual conditions which affect the life of the individual farmer. For him, averages are an abstraction which have comparatively little meaning. He experiences the full flow of these characteristics in combination.

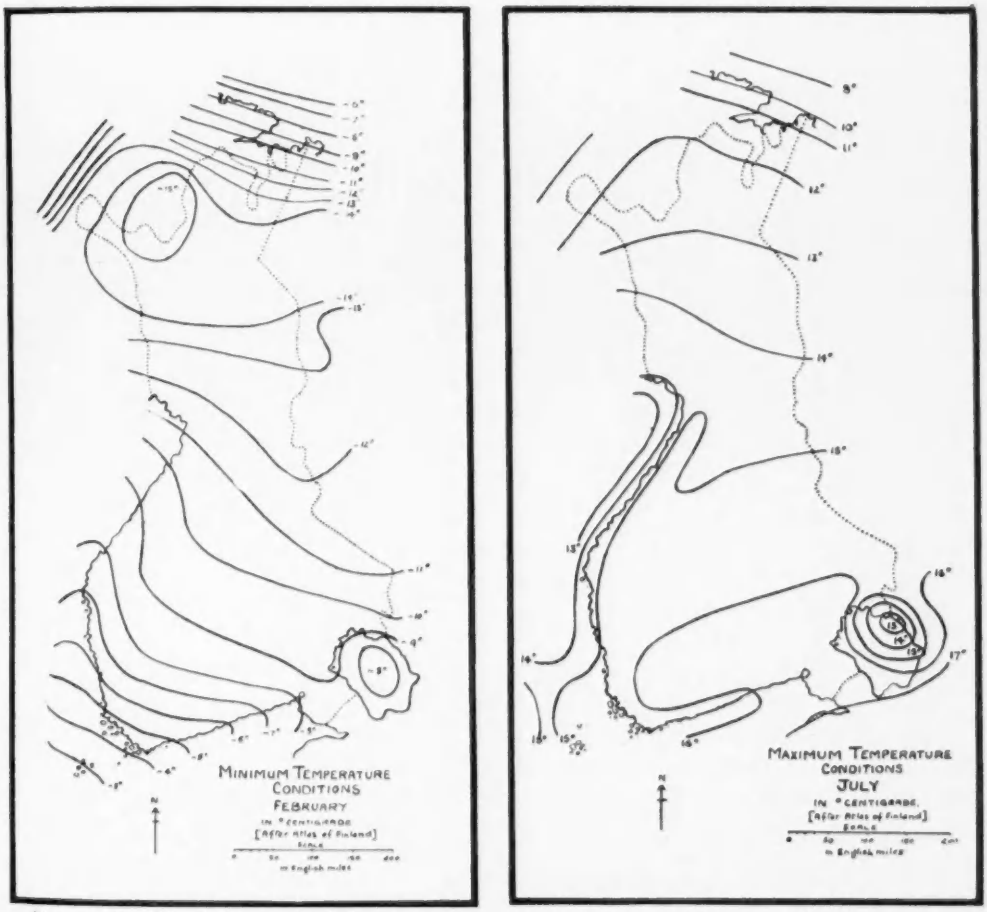

FIGURE 6.—Maximum and minimum temperature conditions. *February.* The emergence of a winter pole of cold over northern Finland is apparent. The pronounced southwestern "bulge" in the isotherms is a reflection of the marked winter continentality. The crowding of the isotherms along the Arctic coast, which remains ice-free, is a point of geographic interest, although for Finland its economic consequences are of small importance under normal conditions. *July.* The close correlation between the isotherms and the contours of the Baltic coast is pronounced and the cooling influence of the sea asserts itself.

He cannot set himself to consider each *in vacuo*.

Local differences from the average are great. This fact is largely attributable to the configuration of the land. The superficial uniformity which characterizes the face of Finland resolves itself into a local complexity. The undulations of the topography and the resulting distribution of water and marshland introduce a host of agencies which modify the procession of the climate as it characterizes the land as a whole. Among the more important factors making for local divergences from the mean are summer frosts. Several causes are cited as producing these dangerous local phenomena which spell disaster to crops. Inversion of temperature may explain their occurrence in the more synclinal valleys. Stagnant air emerging from the expanses of marshland is a possible cause. Development of local high pressure conditions accompanied by drawing in of cold polar air has also been accorded as the explanation. At any rate these *nuits de fer* which are the scourge of the Finnish crop production are equally prevalent as risk increasing factors in Sweden.

The frequency of summer frosts increases from the Aland Isles to the northeast. Settlement upon hill slopes, which are less susceptible to attack, is the natural response of the Finnish agriculturalist to this phenomenon. It provides interesting features in the landscape of eastern Finland, where the grain climbs progressively higher up the slopes of the hills, until outstanding yellow patches shine above the dark green of the surrounding forests. Equally, too, is concentration upon the southward facing hill slopes a result of changeable winds. The Kalevala speaks of "Frost, the son of north wind" and the Bora sweeping down the narrow Mediterranean valleys is no more dreaded than Boreas when he blows across the lakes of Finland in summer.

Except in the plains of the south and southwest, where possibilities of adverse climatic phenomena fall to a minimum, the agriculturalist clings to the hillsides even though he may extend his settlement to the margin of the lake. Thus the combination of soils and climate are balanced one against the other. The knowledge of a poorer but certain yield is balanced against the contingency of a richer, though uncertain yield. In the Lake Plateau agriculture truly reaches the "marginal" form.

Note: The second instalment of this article will appear in a later issue.

LAND TENURE IN THE LEADING TYPES OF FARMING OF PUERTO RICO

Rafael Picó

FARM organization and tenure are of vital importance to the Island of Puerto Rico, a basically agricultural community with a land shortage problem where 506 inhabitants depend directly or indirectly on every square mile of land, and 1,365 on each cultivated square mile of cropland, an efficient type of land tenure is at a premium. Together with efficient management, an equitable distribution of the farm income among all factors of production, such as farmer, laborer, and government (chiefly in the form of taxes), is also imperative in a progressive community with such a dense agricultural population.

During the present century of American domination, efficiency in production has been achieved to a great extent in the leading export commodities of the Island (with the notable exception of coffee which has actually retrogressed) through specialization in a few crops, intensiveness of methods, use of machinery, introduction of higher yielding varieties, and use of thousands of laborers. Puerto Rico's export trade has been increased to several times its 19th Century level, and the Island now enjoys a balance of trade, although not a balance of payments. (Clark, V.S. and Associates: "Puerto Rico and its Problems," The Brookings Institution, Washington,

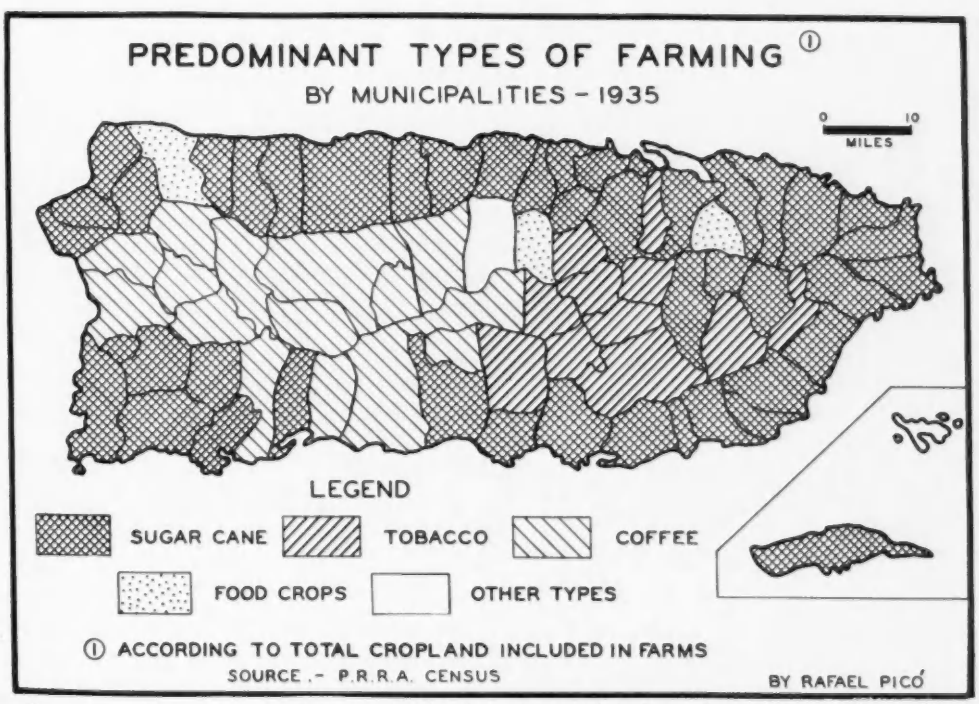

FIGURE 1.—Sugar cane dominates in the level coastal and interior plains of Puerto Rico, coffee in the rugged and rainy west central mountains, and tobacco in the humid east central mountains.

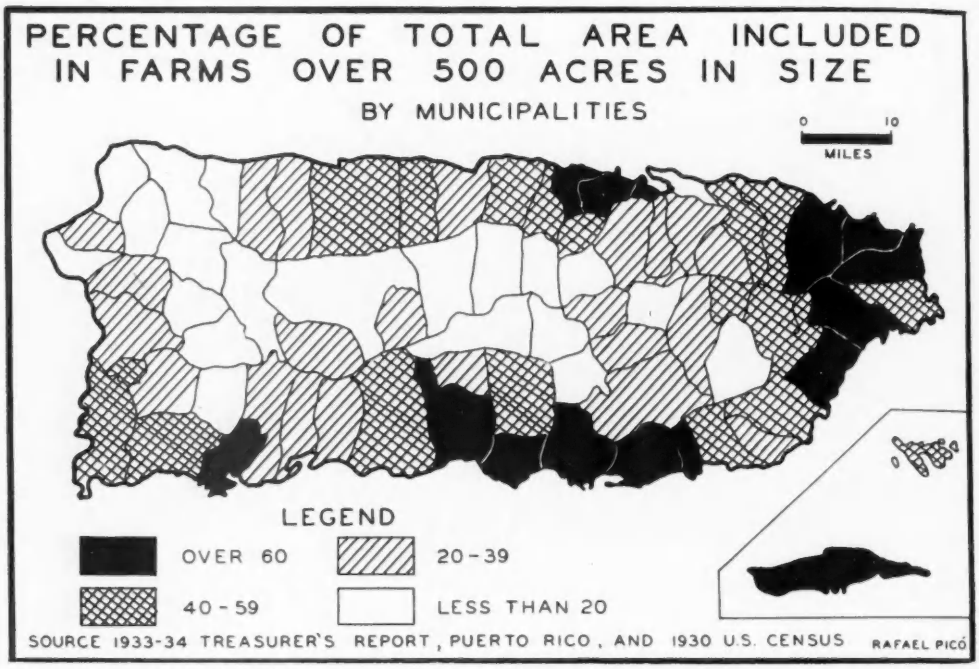

FIGURE 2.—Most of the large farms of Puerto Rico are in the sugar cane regions of the coastal lowlands.

D. C., 1930, Chapter XV.) However, efficiency of production has not raised standards of living of the Puerto Rican masses to a desirable level. Their standards of existence, rather than of living, are still so depressingly low that the appalling housing, health, educational, and food problems of the Island have attracted national attention. As Erich Zimmerman said:

"This overpopulated island is inhabited by what is probably the largest single group of destitute people under the American flag." (Zimmerman, E. W.: "World Resources and Industries," Harper & Brothers Publishers, New York, 1933, pp. 215–216.)

In view of the dependence of the Island on its agricultural industries one of the most important and perplexing problems of present-day Puerto Rico is determination of the best types of farming and land tenure which would modify existing contrasts in distribution of the farm income, without decreasing efficiency of production.

GENERAL LAND TENURE SITUATION

Large farms dominate most of Puerto Rico. Those over 500 acres in size, although only 335 out of a total 52,790 Puerto Rican farms, include 34 per cent of the total area in farms, 30 per cent of the total cropland, and represent 46.6 per cent of the value of lands and farm buildings in Puerto Rico. (Unless otherwise expressed, statistics are taken from "Census of Puerto Rico: 1935," Puerto Rico Reconstruction Administration. U. S. Government Printing Office, Washington, D. C., 1937.) On the other hand, small farms are very numerous, but comprise small acreage and smaller share of farm capital and probably of income. Over 50 per cent of the total number of farms in Puerto Rico are less than 10 acres in size.

However, they include only 7 per cent of total acreage, 10 per cent of cropland, and a meager 6 per cent of value of lands and farm buildings on the Island.

In order to get a truer picture of its importance than the above generalization the land tenure problem of Puerto Rico has to be studied from the point of view of the different regions and crop areas. For example there are striking contrasts between conditions in the southern coastal lowlands and in the east central mountains, as well as between those prevailing in the sugar cane and in the coffee or tobacco industry.

Three leading types of farming dominate the Island's agricultural economy: sugar cane, coffee, and tobacco (Figure 1). In 1935, 58 per cent of the total number of farms in Puerto Rico had one of these three crops as the main source of income. These farms included 77 per cent of the total area in farms, over 83 per cent of the cultivated acreage, and represented a land and building investment equivalent to 82 per cent of the total for the Island. Furthermore, they gave employment to over 175,000 agricultural workers—72 per cent of the total employed in agriculture in Puerto Rico. The products of these farms constitute the bulk of the Island's exports; thus, the economic structure of specialized, commercial Puerto Rico is dependent on conditions in sugar, coffee, and tobacco farms. Practically all geographic regions of Puerto Rico, whether rainy or humid mountains, humid or semi-arid hills, wet valleys, or arid plains include one of these three leading types of farming. (Picó, Rafael: "Studies in the Economic Geography of Puerto Rico," *The University of Puerto Rico Bulletin*. Series VIII, No. 1, September, 1937.)

SUGAR CANE, A PLANTATION INDUSTRY

Sugar cane farms, most important of all, occupy most of the level coastal lowlands and interior valleys with fertile alluvial or limestone soils, and abundant moisture whether from precipitation or irrigation. Normally from 60 to 85 inches of rainfall are received annually by these lands, with the exception of the

FIGURE 3.—View, facing the Caribbean Sea, of some of the sugar cane lands belonging to Lafayette Central. The sugar mill in the left background. (Courtesy of Puerto Rico Reconstruction Administration.)

northwestern and southern coastal lowlands where about 80,000 acres are irrigated by the insular irrigation service, practically all planted to sugar cane. The sugar cane farms number only 12.5 per cent of the total Puerto Rican farms, but they include about two-fifths of total farm and cropland area, represent an investment of 56 per cent of the total agricultural wealth, give employment to almost one-half the agricultural laborers, and produce in a normal year 60 per cent of the total exports of Puerto Rico.

The typical sugar cane plantation covers a large acreage. According to figures taken from the Agricultural Adjustment Administration, in 1934–35, farms 500 acres or over in size, although less than one per cent of the total, covered 65 per cent of the area included in all sugar cane farms, and probably a similar percentage of all cane lands of Puerto Rico (Figure 2). The large farms belong to about 100 landlords operating as independent farmers (*colonos*) and to 41 sugar cane mills of the Island, which in turn represent only 30 corporate or individual owners. Proportional control of the sugar industry exercised by these two types of large farms is decidedly in favor of the sugar mills. The 30 sugar mill owners, besides possessing all facilities for grinding cane in Puerto Rico, directly manage about half the lands devoted to sugar cane production in Puerto Rico, and produce 60 per cent of the total cane grown in the Island. To continue, the land is centralized in still fewer hands. Of these 30 producers, four absentee-owned sugar corporations are as important as

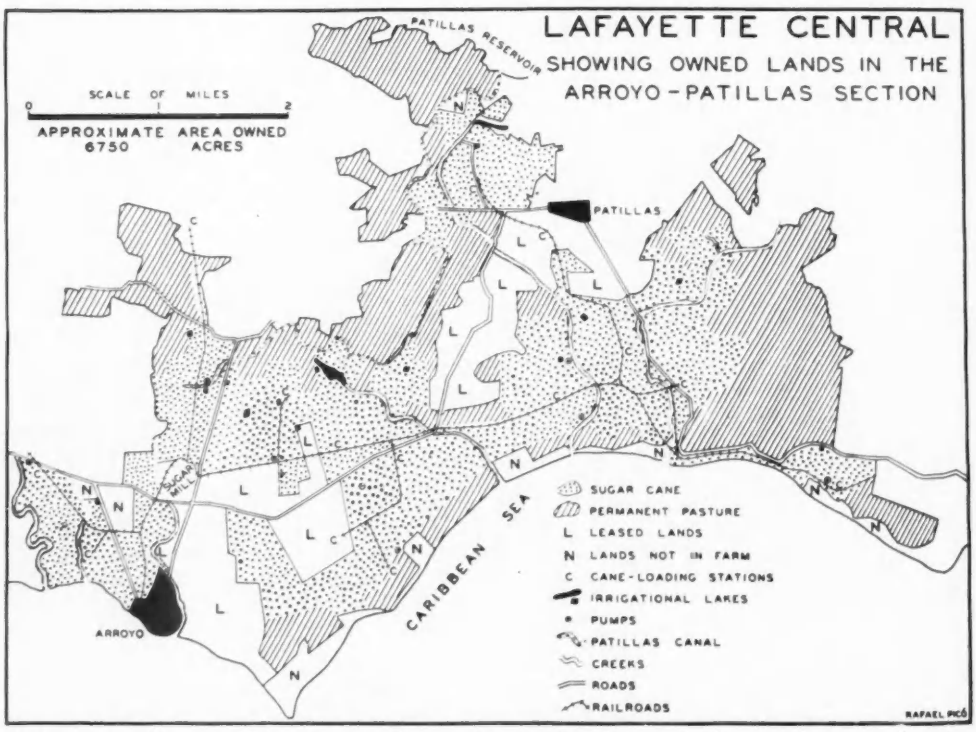

FIGURE 4.—The central is a complex farm unit including thousands of acres of sugar and pasture lands; irrigation lakes, canals, and pumps; miles of roads and railroads; modern mill for manufacturing sugar from the cane; and port facilities (in Arroyo) for exporting the finished product. (Adapted from a map by the Puerto Rico Reconstruction Administration.)

the other 26 units combined. From their own mills comes 45 per cent of the sugar produced in Puerto Rico, of which two-thirds are produced in their own lands, which represent one-fourth to one-fifth the total area devoted to the sugar cane industry on the whole Island. The average acreage directly controlled by each one of these four corporations is over 40,000, half of which is planted to sugar cane. Undoubtedly, the sugar cane mill belonging to an individual or a corporation, with thousands of acres adjacent to it, is the typical and predominant type of farming in the sugar cane industry of Puerto Rico.

FIGURE 5.—The Lafayette sugar mill. In the background level cane fields, bordered by hills utilized only for pasture. (Courtesy of Puerto Rico Reconstruction Administration.)

Several factors facilitated land concentration in sugar cane farming rather than in other crops as coffee or tobacco: (1) a valuable crop with a protected market in mainland United States; (2) extensive level coastal plains or interior valleys where machinery could be used for large-scale farming (Figure 3); (3) abundance of cheap laborers, hundreds of whom could work in the plantations under a few supervisors; (4) many of the lands bought by the big landowners or corporations of the present were formerly in relatively large-sized farms devoted to cane and pasture and, they could be incorporated into a huge estate more easily than small farms.

As an attempt at correction of absentee ownership and land concentration in the sugar industry, in 1935 the Puerto Rico Reconstruction Administration, a federal agency, bought from their French owners the Lafayette sugar mill and lands (Figure 4). The *central* includes about 10,000 acres owned and 8,000 leased, most of it in the eastern corner of the southern coastal plain in the municipalities of Guayama, Arroyo, and Patillas. In all, about 1,200 families were living in the lands owned or leased by the *central*, while a recent survey reported that 860 families with an aggregate population of 4,400 inhabitants had their homes in lands belonging to the mill. (Morales, Otero, P. and others: "Health and Socio-Economic Conditions in a Sugar Cane Plantation," *The Puerto Rico Journal of Public Health and Tropical Medicine*, Vol. XII, No. 4, June, 1937.) About 80 per cent of the 6,750 acres included in Figure 4 are rich alluvial soils irrigated from the Patillas Reservoir of the insular irrigation service, and by eight pumps belonging to Lafayette. The fertile lands are all planted to sugar cane; pasture is limited to the sandy and salty border near the beach and to topography too hilly for machine cultivation and irrigation.

The purpose of the Lafayette project is to subdivide the lands into units less than 500 acres in size operated by the agricultural workers themselves united in a number of coöperatives. Up to June, 1937, eight land coöperatives covering a total of 3,000 acres were organized. Its members work in the field and receive normal wages and steady work, in addition to part of the net profits of both the agricultural and manufacturing aspects of the sugar business. The Lafayette sugar mill is also partially owned by the land coöperatives together with a coöperative of

FIGURE 6.—In a coffee farm near Adjuntas. The cement floor in the foreground is used for drying coffee. Coffee grows under shade on the hillsides of the background.

colonos grinding in Lafayette (Figure 5). Although it is still early to judge the achievements of the new type of coöperative organization, the Lafayette project stands out as a far-reaching experiment of vast social and economic significance. It has all the physical factors needed to make it an efficient business enterprise: level topography, excellent irrigated soils, and a good crop in sugar cane. Success largely depends on the coöperative spirit of the administrators and workers alike in an enterprise which can serve as a "yardstick" for the whole sugar cane industry of the Island.

MEDIUM-SIZED COFFEE FARM

The evolution of coffee farming during this century is entirely different from the successful development of the sugar cane industry. From a predominant position as leading crop during the 19th century, coffee has lost to sugar, and even to tobacco, leading places in the export trade. Gradual loss of the European markets, through tariff restrictions and quotas imposed on Puerto Rican coffee, and absence of protection in the United States market, combined with disastrous effects of hurricanes, have curtailed both coffee production and prices received by the farmer. However, coffee farming is still important in the agricultural economy of Puerto Rico; for one-fifth of the Puerto Rican farms it is still the main source of income. These farms included, in 1935, 22 per cent of the total farm acreage, 25 per cent of the cropland, and 16 per cent of the total capital invested in farm lands and buildings. About 45,000 workers, 18 per cent of the agricultural workers of Puerto Rico, depend on the coffee farms for their existence. In the rainy west central mountains at altitudes of 1,300 to 3,000 feet, coffee dominates use of the land. Cultivated on hillsides where soil is constantly rejuvenated, Puerto Rican coffee is of excellent quality, as a result of mild sub-tropical temperatures, abundant but seasonal rainfall, and excellent methods employed in its preparation for market (Figure 6).

The typical coffee farm is medium-sized; most of the coffee is produced in 150 to 175-acre farms. (Medina, V. y

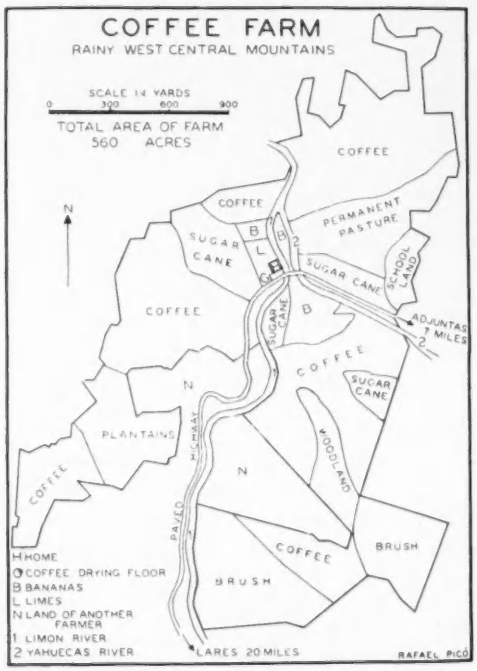

FIGURE 7.—Sugar cane, bananas, and limes are cultivated mainly in the narrow flood plain of the Limon and Yahuecas Rivers; coffee grows on smoother hillsides, while more rugged areas of the farm are brush covered. This farm is considerably larger than average but shows the present tendency toward diversification of crops in the coffee region.

Descartes, S. L.: "El Problema Cafetero de Puerto Rico" Servicio de Extension y Division de Economia Agricola. Enero, 1937 [Unpublished manuscript]). Furthermore, 70 per cent of the total cropland is cultivated by owners; whereas in the sugar cane areas the proportion is only 31 per cent. Undoubtedly the factors of a less valuable crop without protected market in Continental United States, and rugged topography which presents obstacles to large-scale farming, use of machinery, and transportation, and probably some elements of the labor supply have not induced outside capital to invest in the coffee region, nor formation of corporations to control vast areas within it.

FIGURE 8.—In the upper Añasco Valley sugar cane occupies the narrow flood plain while coffee grows on hillsides in the background.

A typical coffee farm shows also more diversity in land utilization than is prevalent in sugar cane farms (Figure 7). Coffee normally covers from one-third to one-half of the total farm area but inter-cultivated with it are shade trees, bananas, and oranges. (Garcia, J. M.: "Facts on Results from Coffee Farming in Puerto Rico During 1934 and 1935"—Mimeographed Report No. 7, Division of Agricultural Economics, University of Puerto Rico, August, 1937.) Because of difficulties encountered in marketing coffee the farmer has turned to other crops to supplant or complement his main crop with other sources of income. Several crops have been tried, especially plantains, limes, vanilla, citrons, and further intensification in bananas. Sugar cane has also invaded this mountainous region and in the more level river valleys or peneplain areas it can be seen growing, sometimes even above the coffee of the hillsides (Figure 8). A large percentage of the farm is utilized very sparingly if at all. Extensive areas are covered with woodland and brush, furnishing charcoal and cord-wood, two typical minor products of the coffee region much in demand throughout the Island, a timber-starved land.

SMALL FARMS AND HOMESTEADS IN THE TOBACCO INDUSTRY

Unrestricted entrance to the protected United States market has stimulated growth of the tobacco industry, only to a less extent than sugar cane production. In 1934, Puerto Rico was one of the leading sources of filler tobacco for the United States; its crop being 40 per cent the total filler tobacco produced in the United States and its possessions. (Nolla, J. A. B.: "Primer Informe Anual del Instituto del Tabaco de Puerto Rico." *Revista de Agricultura de Puerto Rico*, Vol. XXIX, No. 1, 1937.) Physical features in the most important region, the humid east-central mountains of Puerto Rico, have also contributed to the success of tobacco farming. Mild sub-tropical temperatures and protective mists assure a very high grade of filler tobacco. Light early winter rains of the sprinkle type brought by the northerly or northeasterly trade winds provide sufficient moisture for growth of tobacco, a winter crop. At the same time, a less humid late winter helps the tobacco harvest. Soils used for tobacco are generally slightly heavy in texture, but as most of the tobacco is planted on steep slopes or on terraces, drainage is excellent (Figure 9).

The typical tobacco farm is small, the smallest type of unit producing an important export crop in Puerto Rico. According to the 1935 Census about one-fourth of the Puerto Rican farms had tobacco as the main source of income; a larger number of farms than those growing sugar cane or coffee as the main crop. However tobacco farms included only 13 per cent of the total farm area or of the cropland in Puerto Rico, and the value of its fixed capital was only 8 per cent of the total. Nevertheless, tobacco farms in that year gave employment to 15 per cent of the agricultural workers of the Island, showing that tobacco is an intensive crop requiring a great deal of manual labor. In recent studies of hundreds of tobacco farms made by the Division of Agricultural Economics of

FIGURE 9.—Typical scene in the La Plata Farm after purchase and subdivision by the Puerto Rico Reconstruction Administration. Each of the cement houses is inhabited by a homesteader's family which plants tobacco, as shown in the right foreground, plantains, corn, sweet potatoes, "yautías," and other food crops. Tobacco barns in the background.

the University of Puerto Rico it was revealed that the average size for the very small farms was 14 acres, while the larger-sized group averaged only 63 acres. (Toro, Jr., Emilio del: "Brief Facts on Tobacco Farming in Puerto Rico in 1935–36 and 1936–37." Mimeographed Report No. 11, Division of Agricultural Economics, University of Puerto Rico, January, 1938.) There is certainly a marked contrast with the sugar cane estates covering thousands of acres; even the typical tobacco farm is only one-third as large as the typical coffee farm. A fairly large proportion of the tobacco growers (47 per cent) own their farms, while other large groups (31 per cent) are tenants or share-croppers on the lands belonging to other farmers.

Diversification of land utilization is another desirable feature of the tobacco farm. Usually only one-fourth of the cropland is planted to tobacco, although it constitutes 90 per cent of the total farm sales. Corn is usually planted in the spring after the tobacco has been harvested; thus the same land yields two crops a year. Bananas, plantains, beans, sweet potatoes, and yautías are also planted in the tobacco farm as secondary crops.

There is practically no absentee-ownership in the agricultural phase of the tobacco industry, now that the Puerto Rico Reconstruction Administration has purchased the lands of the absentee-owned corporation operating in the La Plata Valley. Absence of the problem can perhaps be explained by marked fluctuations in the tobacco market which can be borne better by a diversified farm than by a one-crop specialized large farm. Furthermore, the mountainous environment and the prevalence of small farms do not encourage acquisition of extensive blocks for huge estates. Also, tobacco farming includes several operations which engage the labor of women and children of the small landowner's family without the cash outlay necessary in a large farm operating on a commercial basis.

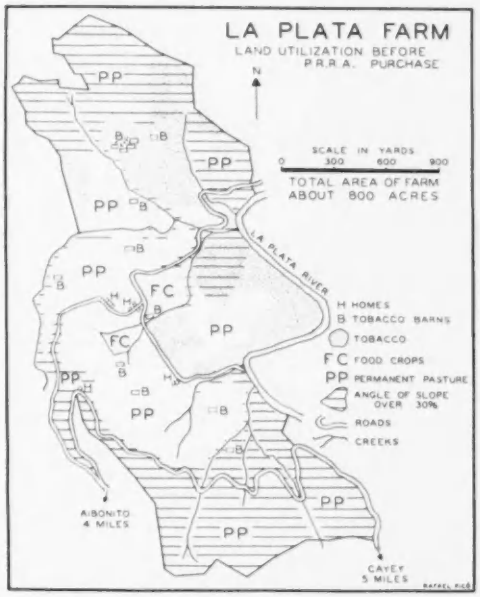

FIGURE 10.—About two-fifths of the farm consists of very steep slopes, some of them over 60 per cent, formerly cultivated to tobacco or covered by poor pasture. Even large areas of the more arable terrace or flood plain lands were utilized sparingly. Food crops covered small acreage. (Adapted from a soil map by the Puerto Rico Reconstruction Administration.)

In the La Plata project of the P.R.R.A., we see another attempt to eliminate large farms and absentee ownership. Formerly, an area of 4,322 acres of land in the La Plata River watershed was held by an absentee-owned corporation which had attempted to produce wrapper-leaf tobacco and for various reasons had failed (Figure 10). The farm was used very sparingly. In 1935, the P.R.R.A. bought this property in order to subdivide it into small homesteads five to ten acres in size. About 450 homesteads will be created in all, 271 of which were already occupied in June, 1937 (Figure 11). Tobacco will continue to be the main cash crop, but many other crops which were little cul-

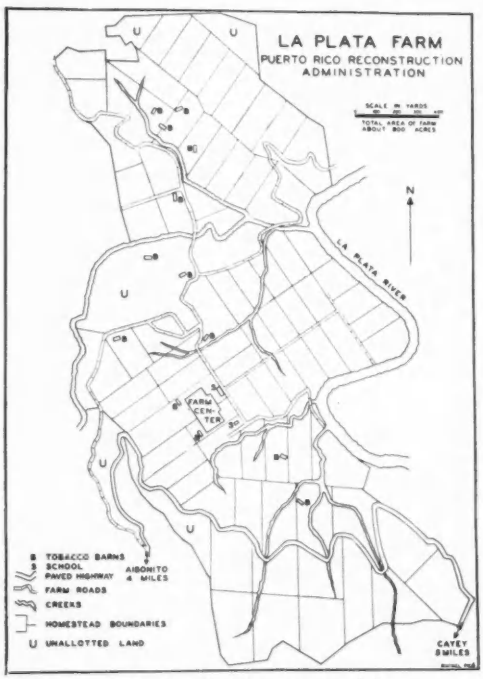

FIGURE 11.—In all 86 homestead farms were established, ranging in size from ten and thirteen acres in the more rugged northwestern and southern slopes, to four and six acres in the terraces and river bottom lands (see Figure 10). Part of the unallotted lands are used by the Central Service Farm and for reforestation purposes. (Adapted from a map by the Puerto Rico Reconstruction Administration.)

tivated in this farm are being planted by the homesteaders (Figure 12). The future of this project looks hopeful. The homesteaders have been established on the land after a careful process of selection. They have been given a good start with a farm, a cement house, and livestock. For all of these they will pay gradually; even a term of twenty years is allowed for payment of house and land. As the farmer has a good cash crop in tobacco with accessible markets, and opportunity to work outside his little farm in near-by larger private farms needing laborers, he will probably earn money to defray his cash expenses. At present he is further helped by the P.R.R.A. through a Central Service Farm which furnishes, for small payments, seeds, agricultural implements, use of the barn, and other services which some central organization can best manage for the use of the numerous small homesteads. Land concentration, absentee ownership, and excessive, unjustified crop specialization are being dealt another heavy blow in the La Plata project.

CONCLUSIONS

The future of Puerto Rico's land tenure system seems to trend toward greater decentralization of management. further subdivision of land and elimination of absentee ownership. A powerful force towards these objectives has been the P.R.R.A. whose activities should be furthered to include other land projects. Now that Federal and Insular governments are earnestly attempting to enforce the Acts of Congress limiting corporate holdings to 500 acres, the strengthening of the above or some other agency is vitally needed to face the problem of the breaking of the large

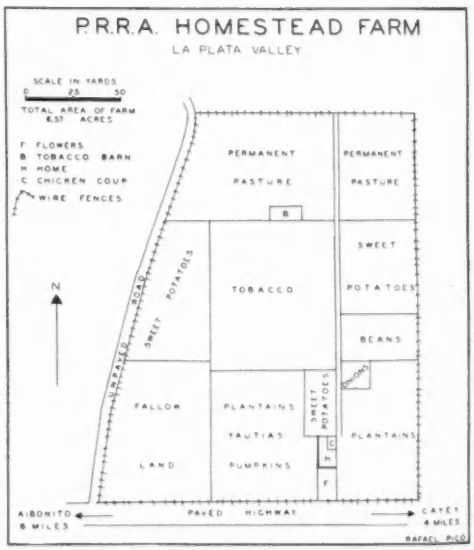

FIGURE 12.—Land utilization in a typical homestead farm. Tobacco is the main cash crop and there are plenty of food crops for family use and for sale.

sugar cane estates if they are outlawed by judicial action, as a result of the cases now being tried before court. (Since May, 1900, corporations operating in Puerto Rico have been prohibited by act of Congress to control over 500 acres of land. Throughout this century this limitation has been either openly violated or evaded by sugar corporations. Only a few years ago did the Insular Government decide to enforce the law and the Insular Attorney General brought proceedings against some of the corporations. The first case tried was decided in favor of the government [August, 1938] in the Supreme Court of Puerto Rico but the defendants have appealed to the Federal District Court of Boston.)

The great problem of the near future is to determine the proper farm type for each geographic or crop region. Shall the land be managed by coöperatives, medium-sized independent farmers, or homesteaders? More research upon the problem is necessary, for each zone must be treated separately in light of its geographic and economic characteristics. Probably in the sugar cane areas coöperatives and fairly large-sized *colono* farms will form the most efficient types wherever large units are required for production. In the coffee zone probably more homestead farms will be created as subsistence units to place the laborers on the land. In tobacco areas the presence of a large number of sharecroppers demand their establishment in farms of their own. In the latter zone the land tenure problem is, nevertheless, fairly well solved, and the small farm should continue to be the backbone of the farming economy of the region.

Note: Part of the material used in the article, especially the illustrations, is taken from the author's unpublished dissertation *The Geographic Regions of Puerto Rico* presented at the School of Geography of Clark University as partial fulfillment of the requirements for the Ph.D. degree.

GRANITE INDUSTRY OF QUINCY, MASSACHUSETTS

J. Nelson Clifford

QUINCY, a city of 80,000 folk, is located a few miles southeast of Boston. It forms one of the semi-circle of towns that front on Boston Bay. Geologically and physiographically it is part of the Boston Basin, which here terminates in a fault contact with the Blue Hills, some of which are located in the southern part of the town.

It is this southern granitic upland which has fostered the quarrying of stone, while the northern lowland plain of glacial outwash has provided level land for the easy establishment of fabricating sheds and transportation facilities (Figure 1). The granite industry has long been associated with this city—so much so that for decades it has been known as the "Granite City." Quincy pioneered the quarrying of stone in this country up to 1850, developing most of the tools and methods of production in use until the turn of the century. In the first half of the 19th century it was virtually the only significant producer of granite in the country and up until quite recently has been one of the three leading producers. Barre, Vermont, and St. Cloud, Minnesota, were the other two. In the peak six years (1923–1928), the industry earned well over $3,500,000 annually (Figure 2), but following 1926 a decline set in which brought the enterprise close to extinction, a condition which has persisted to the present. The causes of this decline are almost entirely economic in character, the original geographic advantages which gave birth to the industry being but slightly impaired. Thus, the Quincy granite industry provides an excellent example of how economic maladjustments may overcome natural geographic advantages to the extreme detriment of an industry.

Rise of the Industry

The first uses of Quincy granite were for the stone walls and house foundations of the early settlers, and the source of the stone until after 1800 was the glacial boulders scattered on the town commons. Methods of sizing were primitive. A fire was built around the boulder to heat it thoroughly, then heavy iron weights were dropped upon it to split it to size. Naturally, only very approximate results were obtained, but they were sufficient for the rough uses to which the stone was put. By 1753 the use of wooden wedges swelled by soaking, and methods of hand-hewing introduced by a colony of Germans made the stone available for finished buildings. About 1800 the iron wedge was introduced. It allowed the source of material to change from the now scarce boulders to the granite hills, and incidentally cut the cost of production in half. On long splits, gunpowder, and later dynamite, was used.

In 1825 a veritable revolution took place in the industry, when, under the stimulus of a large contract to supply stone for the Bunker Hill Monument, the industry had to reorganize and modernize in order to fill the demand. New inventions in drills, tools, and shops—to say nothing of the building of the first railroad in America—brought down the cost of production from 62 cents to 13 cents per cubic foot. A canal was also built to the center of town to facilitate transportation of the large blocks.

Following 1825 with the lucrative Bunker Hill contract and other orders coming in, the granite industry grew. Although of great importance to the town, and long its major industry, its growth was distinctly evolutionary in character. The town never experienced a sudden boom; growth was steady. The reputation of the stone spread, and its favorable location near tidewater, together with the most advanced methods of quarrying, made it the leading building granite in the country from 1825 to 1850. Throughout the era it was the standard of excellence for building stone and was marketed in all parts of the country for public buildings. San Francisco, New Orleans, Mobile, and Savanna all had Customs Houses made of Quincy granite.

A combination of adverse factors conspired to eliminate the stone as a major competitor in the building trades from 1875 to 1880 however, and since then granite has failed to make a comeback in that field. Most of these were economic in character: (1) the advent of cheaper cement and brick combinations, and the rise to favor of the Berea sandstone and Bedford oolite which by 1890 had invaded and captured the near-by Boston market; (2) the fact that expenses of quarrying Quincy granite were far higher than of competing stones; (3) the opening of many competing quarries in other parts of the country which caused a serious contraction of the market; (4) the fire hazard, created by tendency of the stone to cleave when suddenly chilled by water used in fighting fires; (5) durability of the stone buildings tended to far outlast their usefulness and were expensive to dismantle.

The decline was quickly overcome following 1880, due mainly to the realization of a new use for the stone—memorials. The rise in value of production culminated in 1926 in a value of $3,800,000 (Figure 2). Conditions fostering this advance were: (1) high durability, even texture, paucity of mineral segregations and a fair range of color tones allowed easy adaptation to tooling and polishing and the application of a wide range of designs; (2) a number of new inventions and processes were introduced. Quarry methods were mechanized and modernized, pneumatic drills, tools, and other devices greatly speeded production. A new saw, and machine polishing were introduced and gave new life to the memorial business.

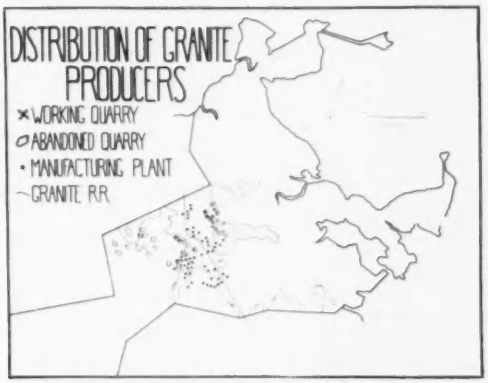

FIGURE 1.—Distribution of quarries and fabricating sheds. Note the location of most quarries above the 100-foot contour which marks the scarp of the southern upland. The sheds are mainly below the contour lines on the flat outwash plain.

Meanwhile the factors affecting the use of the stone in buildings changed. Before 1900 such geographic and geologic considerations as cheapness of production, proximity to water or other cheap transportation, efficiency of labor, modernization of tools and methods, etc. dictated the extent to which a given stone could compete. After 1900, however, price no longer dominated the selection of a stone. Today it is a case of high class stones being sold all over the country at uniformly high prices. The buyer is no longer concerned with prices, he knows that they will be high, but he is willing to pay in order to secure

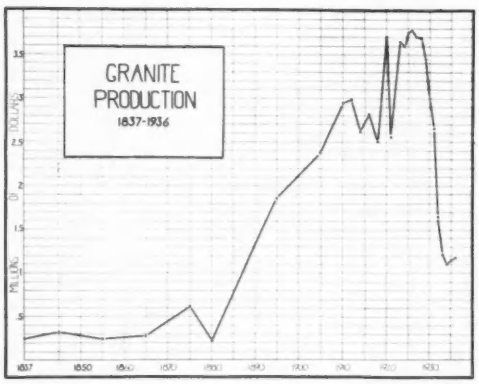

FIGURE 2.—Rise and decline of the granite industry.

a stone that will best suit his architectural scheme. In the United States, high class stone is now bought with little or no regard to its geographical location. Thus we have witnessed a decline of the geographic factor in favor of the geologic and aesthetic.

As to monumental work, the period of the 1920's is most typical of Quincy development at its height (Figure 3). At that time several areas competed in production, but Quincy, Barre, and St. Cloud made more than half of all the monuments in the entire country. Production during this period rose spectacularly, the industry was experiencing great prosperity to which there seemed no end. The 1920's were optimistic years, yet the laxity of method, the lack of modernity were slowly but surely undermining the industry and sowing destructive seeds of decay. In those lush years, decay was not apparent because of the great demand which existed in nearly all markets. Any unit, no matter how inefficient, if it was reasonably within the price range could find a ready market. The producers were lulled into a false sense of security by these conditions and even the strike of 1921 which cost them over a million dollars in a single year (Figure 2) failed to awaken most manufacturers. At the end of 1926 however, the industry gave every indication of good future prospects, but as we shall see in the next section grave changes were to make themselves felt to the detriment of the business.

DECLINE OF QUINCY GRANITE

Following the peak year of 1926, the value of production started to fall off (Figure 2). At first the decline was hardly noticeable, a mere $50,000 from 1926 to 1928, but after 1928 it was a debacle. In only six years (1928–1934) the chart shows a precipitous downward course which was not arrested until little more than a million dollars worth of stone was being turned out annually. This, in an industry which had consistently brought well over three and one-half million for the six years prior to 1929. The drop brought the entire industry to its knees. It was a crippling, perhaps lethal, blow which plunged the business into its lowest production since 1880, and put the industry back at least half a century—so far back indeed, that output for the latest three years available (1934–1936) averages only $500,000 ahead of 1875. Today, it would be impossible to exaggerate the demoralization of the industry in Quincy. Particularly does this apply to the quarrying phase, where, of the few quarries being worked, at least one is using W.P.A. labor, and the others are using but a fraction of their normal complement of workers (Figure 4).

Causes of the decline are complex, and date back to happenings in the early part of the 1920's, and to the operation of various economic factors during the period of greatest prosperity, a time when they were least suspected and their operation most insidious. As nearly as can be ascertained, several factors were responsible.

First, and one of the most important reasons, has been the lack of modernization of equipment and methods. Most of the equipment and methods of thirty years ago are still in use in this city, while competing centers like Barre and St. Cloud adopted new inventions and processes as soon as they were developed. Saws and polishing machines have cut the costs of some operations to a fraction of their former prices, but Quincy remains an inefficient, high-cost producer (Figure 5).

FIGURE 3.—An intensively developed granite producing section of Quincy.

Second, the Quincy dealers and producers have deliberately contracted their market. At one time Missouri, Ohio, Illinois, and Texas were important markets for Quincy monuments. Seventy-five per cent of the sales were then interstate. With a strike in 1921 which paralyzed the industry the producers were unable to fill their orders and lost most of the interstate business. Thirty per cent had become local retail sales by 1928. The depression following 1929 brought new reverses. To minimize losses of immediate profits, the manufacturers increased the retail aspect of their business to the extent that in a short time 80 per cent became local. Today, retail selling is the most important part of the business and a powerful factor in retaining a contracted market. Coupled with this has been a lack of coöperation and correlation between the quarry owner, the manufacturer, and the retailer with consequent failure to promote the local stone even in its own area. What little business is left today is mainly the fabrication of stone imported into the district. Less than 40 per cent of the monuments made in the city are made of Quincy granite (Figure 6).

Third, short-sighted producers compromised the quality and reputation of the stone. Before 1926 the process of "doping" was prevalent. This practice involved rubbing a mixture of oil and lampblack into the face of the monument to make the light, cheaper variety appear to be the more expensive dark

or extra dark. A few years of weathering made these stones so unsightly that many cemeteries passed rules preventing Quincy stones from being set up. Because of this dealers all over the country turned against Quincy granite. Another factor was the occasional appearance of pegmatite "pipes" and mineral segregations in some of the larger blocks. Short-sighted producers passed these on to the consumer. At Barre, more intelligent dealing and the establishment of a common supervisory body certified every stone and kept the quality unimpeachable.

Fourth, injury compensation laws and insurance rates have been highly unfavorable in Massachusetts. In 1926, at the peak of its earnings, the insurance rate was only 2.4 per cent of the payroll. In 1932 with the industry in a profound depression, the rate went up to 12 per cent and the insurance companies that same year refused to underwrite any more policies, canceling those they had. This threw the entire burden directly upon the manufacturers, already much straitened financially. The latest rates available amount to 20 per cent of the entire payroll in the case of men employed fifty weeks per year, and 30 per cent for men employed three days per week, which is the average for depression periods. An extremely large labor differential is the result of these rates, and when added to the normally higher wage levels characteristic of New England it is difficult to see how Quincy is to remain in competition. Of the eight other major producing states not one has a rate exceeding 3 per cent, while the two chief competitors of this city have 1.55 per cent (Georgia) and 1.25 per cent (Vermont).

FIGURE 4.—An abandoned quarry.

Fifth, a variety of miscellaneous causes have also been contributory to the depressed condition of the industry. Chief among them are the rise of numerous competing granite centers in various parts of the country based partly upon the migration of Quincy-trained apprentices in search of greater opportunity, and partly upon the failure of producers to build up a capital reserve, which now prevents them from advertising, modernizing, and dealing on a credit basis, such as all other centers do. A less tangible, but highly important condition is the general pessimistic psychology among most firms. Many of these are so convinced of the ultimate failure of the industry in Quincy that they refuse to invest any more capital in their own enterprise and operate in an almost desultory fashion; perhaps they are justified—only time can tell!

CHANCES FOR FUTURE RECOVERY

Since 1934 production has been very small. Private production of quarried stone has been almost nil of late. The value of products reported to the state

FIGURE 5.—Abandoned cutting shed. A monument to inefficiency.

has become more and more the value of stone imported in the rough state and manufactured into monuments. Since 1928, 60 per cent of the total sales have been of monuments made of imported stone. Besides granite brought from the other New England states and from the south, foreign granites from Sweden and Finland have come nearly to dominate the market. The recent trade treaty with Finland in which the tariff on finished monuments has been reduced from 60 per cent to 30 per cent now threatens to allow that country to take over the entire market for red granite which Quincy manufacturers alone have built up in New England. It is also feared that Finnish gray stone will also capture the market for that type, and thus force out the little remaining production of native Quincy granite.

Thus, the industry here is in a state of extreme old age. If trends continue as at present, eventual extinction is certain. If an abrupt about face is made by those interested in the business, it may have a chance of survival. Even so, the rejuvenation would be a long uphill fight. Cases of industrial comebacks are rare, since most industries decline as a result of the evolution of world economic relationships and are unable to adapt themselves to the changing conditions. This seems to be the case in Quincy. With all the harm that has been done in the last twenty years it will take thousands of dollars to give the business enough of a start to hope for success, and no person or group seems to be willing to risk money in such a decadent industry. Recovery appears to depend upon the following conditions: 1. Modernization of the plants and equipment, and reorganization of the business to increase efficiency, lower costs, and prices. 2. Better coöperation between quarry producer and manufacturer. Perhaps the merging of the seventy-odd firms into a single corporation would be desirable. This would cause all to pool their resources, stop price cutting, and raise efficiency. 3. Improvement and assurance in the quality of the stone by culling the blocks at the quarry, and establishing a common supervisory body to approve every stone as to quality, finish, etc., before it is allowed upon the market. Every

FIGURE 6.—Only two of the stones shown in this cutting shed were quarried in Quincy.

stone should be designated with a characteristic trade-mark (at Barre it is "The Rock of Ages"). Adaptation of the designs to fit the peculiar qualities of the stone should also help. 4. Passage of more favorable legislation on accident insurance to lower the huge labor

differential. 5. Construction and maintenance of an adequate capital reserve for the purpose of constant modernization, advertising, and credit dealing. At Barre credit may be carried six months; at Quincy almost immediate payment is required. 6. Inauguration of a huge nation-wide advertising campaign to rebuild prestige and dignity. 7. Abandonment of the direct selling which limits the market to the Boston area and New England in favor of regional dealerships in various parts of the country. 8. Establishment and maintenance of a separate department to discover new uses for the stone, and to contact architects and builders to introduce the stone as a base and building trim for which the polished granite is eminently suited.

Thus it seems that the industry needs to be rehabilitated. On the other hand it still has only slightly impaired the original geographic and geologic advantages that gave birth to the industry. With vigorous organization at the head of a movement for rehabilitation, the advantages might again assert themselves. Everything hinges upon whether or not necessary leadership is forthcoming. The original question remains unanswered: "Will Quincy granite come back?"

APPENDIX: GEOLOGY OF QUINCY GRANITE

The Quincy granite, or Blue Hills batholith, occurs in a roughly elliptical area with the major axis nearly east-west and about nine miles long. Both east and west ends are probably faults. On the north there is definite fault contact with the sediments of the Boston Basin, while on the south there is fault contact with Cambrian slates. Thus the batholith in this area is surrounded by great

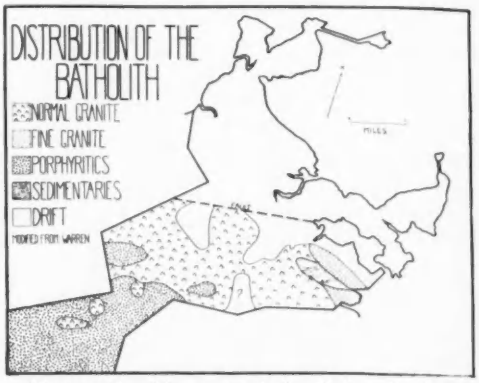

FIGURE 7.—Elements of the Quincy batholith with associated features.

major faults, and is itself a fault block which has been elevated and tilted, especially at the southwest where the present Blue Hills mark the place of greatest uplift (Figure 7). Other exposures of this same intrusion outcrop at Rockport, Massachusetts, and at Diamond Hill, Rhode Island.

The typical Quincy granite is a gray rock of from light to dark shade variation. The manufacturers recognize four principal classes of stone: Light, Medium, Dark, and Extra Dark. The variation is due to the differences in the amount of black silicates and the smoky quartz, and in part to the degree of kaolinization of the feldspars. Constituents in the order of their abundance are: orthoclase—twinned and dark gray in color; smoky quartz—medium to dark with a blue tinge; albite and oligoclase; riebeckite and aegerite—blue-black and green-black. By percentage the constituents are: Feldspars, 60.02; Quartz, 30.60; Horneblende, 9.37 (Rosiwal measurements).

The geological age of the granite is Mississippian. It is interesting to note that by curious coincidence the leading building stones of the present day, the Bedford oolite and the Berea sandstone, are also of Mississippian origin.

CLIMATE AND AGRICULTURE IN CALIFORNIA

M. K. Bennett

CALIFORNIANS pride themselves on the contrast and variety of their state. The average citizen knows that from the highest point of land in the United States, Mt. Whitney, it is possible to look down into the lowest, Death Valley; that one can spend his winter week-end either skiing in the Sierras or golfing near the coast; that on a midsummer day one can drive within two or three hours from dry scorching heat in the interior valley to a seashore definitely cool and probably foggy, or can wait for night to fall and bring with it comfortable temperatures. These contrasts find professional expression in the fact that Russell (R. J. Russell: Climates of California, *University of California Publications in Geography*, Vol. 2, 1926, pp. 73–84) and Thornthwaite (C. W. Thornthwaite: The Climates of North America, *Geographical Review*, Vol. 21, 1931, pp. 633–655; The Climates of the Earth, *ibid.*, Vol. 23, 1933, pp. 433–440) each distinguish eleven types of climate within the boundaries of the state. On Thornthwaite's basis of classification (not identical with Russell's), only ten additional types can be found elsewhere in the world's temperate zones. No other state of the Union offers so wide a range: even the vast expanse of Texas contains only five climates, and large states like Alabama, New York, Iowa, and North Dakota only two.

Contrast and variety also characterize the agriculture of California. Here the subtropical lemon can be seen growing in the next field to the sugar beet that flourishes in Michigan or Denmark; the warmth-loving olive within a few miles of the apple that will survive New England winters; moisture-loving rice beside drought-resisting barley and grain sorghums. The characteristic cultivated plants and trees of the temperate and subtropical zones, whether wet or dry, are mingled in the agriculture of California. Here are found also, and in substantial numbers, all of the important draft animals and the productive animals and birds outside of the tropics—horses, cattle, swine, sheep, goats, hens, turkeys, ducks, and geese.

Baker has said of California: "No other state compares with it in variety of crops." (O. E. Baker: Agricultural Regions of North America. Part VIII. The Pacific Subtropical Crops Region, *Economic Geography*, Vol. 6, 1930, pp. 166–190, 278–308.) He remarked further that the Census gives reports for California on the production of every grain crop, every kind of hay, every vegetable, every fruit, and every other crop grown and reported upon in the United States with the trifling exceptions of horseradish, kumquats, pineapples, mangoes, sugar apples, sapodillas, sugar cane, maple syrup, castor beans, chufas, ginseng, peppermint, and teasels. And even some of these are absent only in the sense that census officials find them so unimportant as not to warrant counting the acreages.

Another aspect of variety in Californian agriculture is the presence within the state of thirteen dominant types of farming, broadly distinguishable one from the other on the basis of proportional contribution of different farm products to the farmer's income. There are only twenty such dominant types of farming in the United States; no other state boasts more than ten; and most

states have only four or five. (See map: Type-of-Farming Areas in the United States, 1930, by U. S. Bureau of Census, Department of Commerce, in coöperation with Bureau of Agricultural Economics, Department of Agriculture.)

CLIMATIC DIVERSITY

It is natural to ascribe the diversity of Californian agriculture to the diversity of climate, and to regard this diversity of agriculture as notably exceptional among the agricultures of the world.

FIGURE 1.—Land relief of California. (Courtesy of Department of Geology, Stanford University. Model by N. F. Drake.)

But the climates are not strikingly diverse within the principal agricultural area of California where the crops are grown. Indeed, they resemble a theme with variations. The "agricultural area" includes the flat and rolling lands with soil suitable to plow. Almost all of this agricultural area lies within the great interior valley of the Sacramento and San Joaquin rivers; the smaller intermontane valleys of the Coast Range particularly those of Sonoma, Napa, Santa Clara, and Salinas; the coastal plains around Eureka, Santa Cruz, San Luis Obispo, Los Angeles, and San Diego; and, inland, the Imperial Valley in the south and in the northeast the broken plateau of Modoc and Lassen counties. The great interior valley is much the largest of these subdivisions of the agricultural area.

The agricultural area is in general characterized by a climate variously called "Mediterranean," or "dry subtropical," or "subhumid to semi-arid, mesothermal, with deficiency of rain in summer." Its salient features are moderate to scanty annual rainfall; a long frost-free season; and a seasonal distribution of precipitation such that the great bulk of it comes in the late autumn and winter, and little or none in late spring and summer.

Among twelve cities scattered throughout the agricultural area (excluding the interior northeastern plateau and the Imperial Valley), the range of annual rainfall is from an average of only 8.3 inches at Hanford in the southern stretch of the great interior valley, to 39.0 inches at Eureka on the northwestern coast. As Figure 2 shows, the growing season (average frost-free period) is long. Among the twelve cities referred to, it ranges from 204 and 205 days respectively at Santa Rosa and King City in coast-range valleys, one north and one south of San Francisco, to 359 days at Los Angeles on the southwestern coast and 305 days both at Sacramento in the north-central part of the interior valley and at San Jose at the southern extremity of San Francisco Bay. The growing season tends to be shortest in the intermontane valleys of the Coast Range. Winter temperatures practically everywhere preclude snow and permit late autumn sprouting and some degree of winter

growth of natural grasses or sown grains.

The rainiest four months at all twelve points are December-March; the driest, either May-August or June-September. Only two of the twelve stations get as much as an inch of rain in any month of the five-month period May-September; these two are Eureka and Santa Rosa in the northwestern portion of the state. Drought therefore prevails for nearly half of the year; and late in April over most of the agricultural area the green-clad countryside begins to turn brown, to remain so until November or December. In the hottest month of the droughty summer season, maximum temperatures (see Figure 2) may average nearly 100 degrees Fahrenheit, especially in the interior valley; but the intermontane valleys of the Coast Range, and particularly the coastal plains, are cooler. In the interior valley itself the nights are much cooler than the days, as is suggested by comparison of the monthly averages of daily maximum and of daily minimum temperatures shown in the chart.

CHARACTERISTICS OF CLIMATE

Broadly similar climates are found elsewhere in the world. Like the climate of the agricultural area of California, they center around the 35th degree parallel in each hemisphere, lie on western exposures of continental land masses, and merge into true desert climates on their equatorial fringes. The largest land mass covered by this general type of climate borders the Mediterranean Sea—whence the common name. This is the climate roughly of the southern portions of Spain, Italy, and Greece; of the western fringe of Asia Minor; of the northern portions of Tunis, Algeria, and Morocco. It is the climate of central Chile west of the Andes; of the southern tip of Africa; and of the westward-facing southern coastlands of Australia.

Figure 3 summarizes climatological data (monthly average precipitation and temperatures) at eight cities located within the four climatic areas akin to that of the agricultural area of California, and also for two points in California—Santa Cruz on the coast, relatively moist and cool, and Merced in the interior valley, relatively dry and hot. The annual precipitation at two of these eight foreign cities exceeds that at Santa Cruz (but is below that of Eureka); in all of them it is higher than at Merced. In most of the foreign

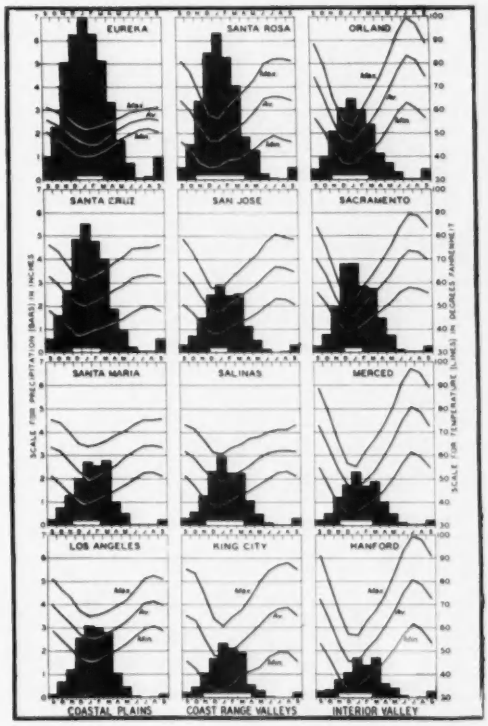

FIGURE 2.—Climatological data for twelve stations in the agricultural area of California. Vertical black bars represent monthly average precipitation; horizontal white bars, average span between first and last killing frost; successive solid lines, monthly means respectively of daily maximum, daily average, and daily minimum temperatures. (Long-term averages from U. S. Weather Bureau, *Climatic Summary of the United States*, Sections 15–18.)

points, winter temperatures are higher than those at Merced, but summer temperatures are not so high except at Athens and Beirut. At most of the foreign points, the seasonal distribution of rainfall differs from the characteristic Californian distribution in three respects: the month of heaviest rainfall is November or December (in the Southern Hemisphere, June) rather than December or January; the rainy season extends a little later into the spring, May rainfall being somewhat more abundant than in California; and the drought season of June-September is not quite so dry. Tentatively, the generalization may be ventured that characteristically, both the seasonal rise of temperature and the seasonal decline of precipitation from January (July in the Southern Hemisphere) to the late spring are on the whole more rapid in California than in most other climates similar in general type.

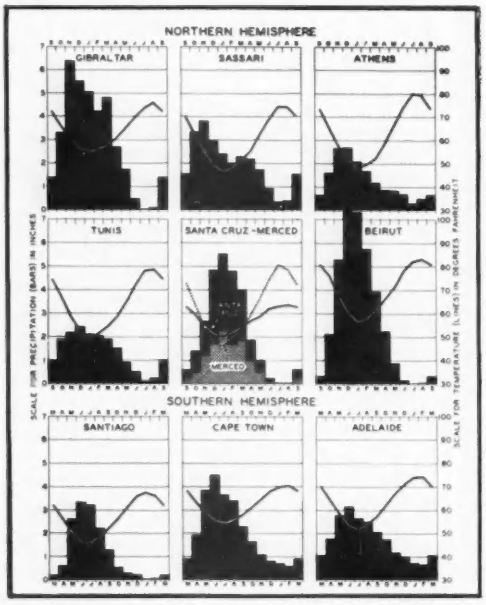

FIGURE 3.—Climatological data for eight foreign stations in regions of Mediterranean climate, and for two stations in California. Vertical bars represent long-term monthly average precipitation; horizontally running lines monthly means of daily average temperatures which in turn are usually means of daily maximum and daily minimum. (Foreign data from *Smithsonian Miscellaneous Collections*, Vol. 79 [1927]; for source of California data see Figure 1.)

Within these sister climates, the range of agricultural products is very much the same as in California. These are lands where irrigated agriculture mingles with dry farming. Over wide stretches they are warm enough for rice, citrus fruits, and cotton, if irrigated, but cool enough for irrigated sugar beets. They are dry enough, but in wide areas not too dry, for unirrigated wheat and barley, which in the stretches that approach deserts are commonly grown in rotation with fallow so as to conserve moisture. They are eminently well suited to grapevines, olives, apricots, plums, and almonds, which grow well in the moister reaches unirrigated, and in the drier stretches under irrigation. Perhaps the most typical unirrigated crops are wheat, barley, beans, grapes, apricots, almonds, and olives.

Without irrigation, the Mediterranean climate generally is not well adapted to growth of grass, leguminous hay, rice, corn, grain sorghums, cotton, tobacco, or root crops like potatoes, sugar beets, and turnips. Only in the restricted regions that are *both* warm and wet is it adapted to citrus fruits. In general, all of these crops require a longer time to grow and more moisture in their growing season than the Mediterranean climate provides. The weeks are few between the cool winter when plant growth must at best be slow, and the onset of drought in the late spring or early summer. In this respect, California is perhaps the least favored of the Mediterranean climates.

From the agricultural point of view, the Mediterranean climate, without irrigation, is not highly productive. The span is too short between the winter season when annual plants can make

little growth and the practically rainless summer season when growth must cease. This prevents cultivation of the productive slow-maturing annual plants, and also tends to hold down the per-acre yield of some of the rapidly-maturing and less productive annual plants. (For example, the postwar average yield per acre of wheat within Mediterranean regions of substantial size very rarely equals 15 bushels, and often falls below 10 bushels. See M. K. Bennett and Helen C. Farnsworth: World Wheat Acreage, Yields, and Climates, *Wheat Studies*, Vol. 13, 1937, tabulations on pp. 303–308.) Steeply declining rainfall accompanied by rising temperatures in the period between sowing and harvest is not favorable to yields of such plants. Nitrogenous fertilizers, as in all dry climates, are not effective in enhancing yields, though phosphates are of vital importance in the phosphate-deficient soils of Australia. Rotations that exclude fallow are difficult to develop. The peculiar virtue of the Mediterranean climate unmodified by irrigation is, in its moderately moist stretches, the advantages it affords for grapes and a rather wide range of fruits and nuts. Among these advantages are relative infrequency of hail or of strong winds, and the dry sunny summer that facilitates curing of fruits

Wherever irrigation is feasible in the Mediterranean climates, it is possible to expand the range of crops grown to include both those of moisture-loving subtropical types like the citrus fruits, rice, and cotton, and the moisture-loving temperate-zone types like corn, alfalfa, sugar beets, and tender vegetables. The subtropical types, however, naturally tend to be grown in the warmer parts of any Mediterranean climate, the temperate-zone types in the cooler parts. Irrigation also widens the geographical spread of vines, fruits, and

FIGURE 4.—Snow pack in the Sierras: Stored water for irrigation. (Courtesy of California State Chamber of Commerce.)

nuts in any Mediterranean climate by supplying moisture to carry them through the summer drought. In the warmer stretches, irrigation also permits the production of two or three crops of rapidly-maturing vegetables from a field in one year.

CONCENTRATION OF AGRICULTURE

Thus Californian agriculture is not distinguished from the agriculture of other regions with the Mediterranean type of climate by the variety or range of its products. First and foremost it is distinguished by a far different concentration within the range—a concentration due fundamentally to the wider prevalence of irrigation.

At present the area of California farms is about 30.5 million acres. More than two-thirds of it is woodland and pasture. Somewhat less than the third that remains may be called cultivated land. Of this cultivated land, covering about 8.7 million acres, nearly a fourth is usually unproductive—either in fallow, or idle because it is not planted or because the planted crops fail. Over a third of the cultivated land is used for crops of intensive or semi-intensive types, those involving much labor and capital and little land. Among the

intensive are counted the grapes, fruits, nuts, vegetables, sugar beets, and cotton; among the semi-intensive, the alfalfa, rice, and corn. The residue of the cultivated land, about two-fifths of it, is used for crops of extensive type, involving much land and little labor or capital. Barley occupies the largest area of these extensive crops; then follow hay and forage of diverse kinds, including small grains cut for hay; then wheat cut for grain; then field beans and peas. The land from which crops are harvested is divided almost equally between that producing semi-intensive and intensive crops on the one hand (crops that may conveniently be called "non-extensive"), and on the other hand that producing extensive crops. (Acreage data mainly as given in *Census of Agriculture* for 1934.)

This approximately equal division of crop land between extensive and non-extensive uses distinguishes Californian agriculture from the agriculture of all other regions of Mediterranean climate. In Algeria, the intensive and semi-intensive crops occupy only about a fifth as much land as the extensive crops; in Australia still less. Even in Italy as a whole, only two-thirds as much land is devoted to the intensive and semi-intensive crops as to the extensive; and the proportion is lower in the southern half of Italy where the climate more closely resembles that of California. (Based on acreage data from *International Yearbook of Agricultural Statistics, 1937–38.*)

Because of the emphasis upon intensive and semi-intensive crops, Californian agriculture has often been called exceptionally productive. And so it is with reference to value of agricultural products per acre of farm land available for crops (including the land idle and fallow), and with reference to regions with similar climates. Since intensive crops tend to be valuable crops, it may be inferred even without the pertinent statistics that the relative importance of these intensive crops in California as compared with other regions of similar climates indicates a relatively high productivity of Californian agriculture in terms of per-acre values of product. The inference is all the more justified because California farmers produce intensive crops of remarkably fine quality.

Yet it would overstate the case to say that Californian agriculture is more productive than any other regardless of climate. In terms of income from sales of produce per acre of land available for crops, for example, Florida ranks on a par with California, New England ranks a little higher, and New Jersey nearly 50 per cent higher—reflecting broadly still greater emphasis on intensively cultivated valuable agricultural products. (Based on official estimates of gross income from farm production by states, 1934 and 1935 (*Agricultural Statistics, 1937*), divided by summations of census data on land available for crops plus areas in orchard and vineyard.) Presumably Denmark, Germany, and northern France would also rank above California.

It would be unwise to guess how Californian agriculture compares with others in productivity of another kind—the net income per farm family expendable for family living. This is a complex question, and much depends upon the amount of land operated by a farm family.

CHARACTER OF AGRICULTURE

The agriculture of California is commonly further characterized as specialized, commercialized, and mechanized. The farmers tend to specialize on one or two marketable products or groups of allied products. Most citrus growers

produce nothing but citrus, most prune growers practically nothing but prunes and apricots, a great many barley farmers nothing but barley and wheat, and so on. Relatively rare in California are farmers who, like most of the Danes, sell as long a list of products as milk, eggs, pigs, grain, and sugar beets. The so-called "general farm" so common in many states is not a type of farming found among the thirteen in California. The agriculture of California is commercialized in two senses: individual farmers produce for sale and rarely for household consumption, so that the subsistence type of farming is so rare as not to be listed; and the state as a whole ships much of its farm output to other states and foreign countries. Mechanization is highly developed. Tractors, trucks, combines, pumps, seed-drills, milking machines are familiar instruments, to mention only some of the larger and more expensive ones. Some farmers even sow rice by airplane.

It can further be said truthfully that Californian agriculture is highly organized and notably progressive. Farmers group themselves into coöperative associations, and are alert to adopt improvements of crop varieties and of agricultural practice.

But Californian agriculture does not stand out as definitely more specialized, commercialized, mechanized, organized, or progressive than the agricultures of *all* other regions of similar climate. In these respects the agriculture of Australia is similar, though the agricultures of the Mediterranean littoral and central Chile are very different, and South Africa stands in an intermediate position. The features that sharply differentiate Californian agriculture from that of *all* regions closely similar in climate are its emphasis upon the non-extensive crops, and its associated high productivity in terms of value of product per acre of land available for crops.

These in turn rest mainly upon the ratio of irrigated crop land to total crop and fallow land. Nowhere else within the Mediterranean climates of the world is there a block of nearly 9 million acres of arable land with somewhere around two-thirds of it irrigable from waterworks already constructed. (In 1930, the irrigation enterprises of the state were estimated to be capable of supplying water to 6.8 million acres (*Statistical Abstract of the United States, 1937*, p. 569). Not all of this acreage, however, was necessarily part of the 8.7 million acres of cultivated land.) Over 3.5 million acres of crops were grown on irrigated land in California in 1934, out of a total acreage of harvested crops of 6.6 million acres.

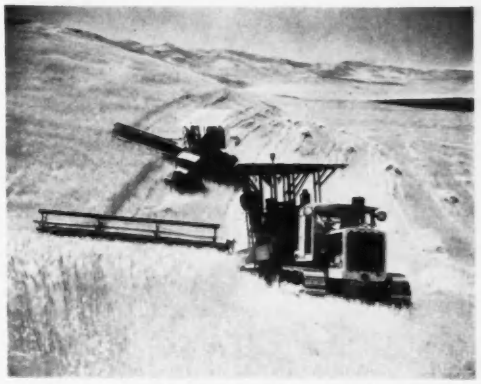

FIGURE 5.—Harvesting unirrigated barley by combine, typical of foothill country. Fallow in background. (Courtesy of Pacific Rural Press, San Francisco.)

The growth of this irrigated area is the major factor that has changed California within half a century from a region of predominantly extensive agriculture like Australia today, not notably productive, to a relatively productive region where semi-intensive and intensive agriculture is strongly emphasized. Fifty years ago, in 1888, the state had three million acres in wheat, led all other wheat states except

Minnesota, and exported large quantities. Today the wheat acreage of California is only a fourth to a third of what it was 50 years ago, and wheat is imported regularly. Extensive types of agriculture have lost ground to intensive types, and irrigation was the principal instrument. (See E. D. Fagan: Some Theoretical Factors in the Migrations of the Wheat Belt in the United States, *The Balance Sheet* [Cincinnati, Ohio], September 1929, Supplement, pp. 3–7.) It is difficult even to imagine how different Californian agriculture would be if there were no irrigation. Enough, perhaps, is suggested by the facts that California farmers now harvest about 1.5 million acres of rice, cotton, alfalfa, sugar beets, and citrus fruits, of which practically none would be grown without irrigation; this is between a fourth and a fifth of the total acreage in harvested crops; and in addition there are hundreds of thousands of acres now planted to vegetables, vines, and various tree crops which could not be used for those crops without irrigation.

FIGURE 6.—Cultivating a large vineyard in southern California, typical of San Joaquin vineyard districts. (Courtesy of Pacific Rural Press, San Francisco.)

Irrigation in California is both by dam and ditch in specially formed irrigation districts, and by well and pump on individually owned establishments. Particulars as to importance of the two types are not available. In the great interior valley, however, irrigation is mostly by dam and ditch, utilizing water impounded on the western slope of the Sierras and derived both from direct run-off after rains and from run-off due to melting of the heavy winter snow-pack in spring and summer. Much less land is irrigated in the Sacramento than in the San Joaquin basin. The former has abundant unused water supplies, and new reserves following construction of an enormous dam near Reading in the upper Sacramento Valley will enlarge water supplies far to the south in the San Joaquin region. The Imperial Valley in extreme southern California draws irrigation water mainly from the Colorado River. In the intermontane valleys of the Coast Range and on the coastal plains, irrigation is mostly from wells, though around Los Angeles mountain water is also used. Water levels tend to decline in many or most of the coastal valleys and plains, and costs of lifting tend to increase. In order to achieve maximum replenishment of underground water, many cheap catchment dams have recently been erected in foothill country. They are so managed that winter rains, instead of running out to sea, are caught and fed slowly into stream-beds, there seeping underground.

Undoubtedly the great development of irrigation in California in part represents natural advantages—high mountains flanking a great expanse of agricultural area, with heavy precipitation in the mountains and a considerable fraction of it stored by nature in the

form of snow. It is probably true that no other large agricultural area in Mediterranean climates has a hinterland of mountain equally favorable for development of irrigation projects. But the favorable natural environment does not fully suffice to explain why irrigation is relatively so conspicuous in California; something depended upon economic prospects for profitable use of land once brought under irrigation.

THE AGRICULTURAL PROSPECT

Irrigation works, whether by dam and ditch or by well and pump, represent investment of capital. This investment required motivation. The obvious motivation was that men expected to receive a return when they placed investments in Californian irrigation—at least interest at current rates, amortization of capital in the course of time, perhaps something more. In many particular instances the investors were probably disappointed. But it is worth while to try to understand why so many people should have expected to receive good returns from investment in irrigation works in California.

A dominant factor in their expectations was anticipation of a market for fruits and vegetables wide enough to absorb increasing quantities at remunerative prices. Without the emergence of such a market particularly in the eastern part of the United States but also in western Europe and in California itself, Californian agriculture could not have followed its historical trend; and investors in irrigation works in California would not have been justified in expecting reasonable returns from their investment.

At least until the onset of world-wide economic depression in 1929, there was good reason to anticipate emergence and long-term growth of a remunerative market for the valuable, expensive, intensively-grown crops of California. The fundamental influences were obscurely felt and recognized, if not often fully and clearly expressed, by investors and farmers themselves. In those days people generally had a vague faith in the future of the country, even of the world. If that faith meant anything tangible, it meant belief in a persistent trend toward increasing per-capita consumption of goods and services, often called a rising standard of living. The belief rested on experience. It was easy to see that many peoples of the world and particularly those of the United States actually were consuming more goods and services per capita than they had done a decade or two or three before. It was even easy to perceive, with a little reflection, that the rising standard of living rested on persistently increasing efficiency of the manifold processes of

FIGURE 7.—Irrigating a pear orchard in the Santa Clara valley. (Courtesy of Berton Crandall, Palo Alto.)

production in industry, agriculture, and commerce.

If persistently increasing efficiency of production throughout the economic world could be assumed, then an investor in irrigation in California might have argued as follows: "The future will witness rising standards of living at home and in many places abroad. When standards of living rise generally, food standards rise also; people can and will reduce their consumption of cheap foods like bread and potatoes, and increase their consumption of all sorts of more expensive foods, including fresh and canned green vegetables and fresh and canned and dried fruits. The people will do this because they like to, and also because they will be able to afford to see the doctor oftener, and he will tell them to do it. There will also be more and more people. Therefore there is a good reason to anticipate a reasonable return on investment of money in Californian irrigation that will produce these expensive items. And there is all the more reason to do so if, as in the past, improvement continues in the speed and safety of transporting these things to markets two thousand miles or more away."

This may not have been the precise chain of reasoning openly expressed by any particular investor; but prudent long-term investors very probably acted upon reasoning of much the same drift. They had faith in the growth of a remunerative market for the expensive agricultural products that could be grown under irrigation in California.

The whole structure falls apart if one cannot pre-suppose persistently increasing efficiency of economic processes, which is sometimes described as rising effectiveness of labor. Without this presumption, standards of living, and standards of food consumption involving wider use of expensive perishable foods,

FIGURE 8.—Orange grove near Redlands in winter.

FIGURE 9.—Irrigated cantaloupe field in Imperial Valley in late winter; young plants protected. (Courtesy of California State Chamber of Commerce.)

are not likely to continue to rise. And if one cannot pre-suppose continued growth of population, the growth of a remunerative market for expensive perishable products is likely to be slowed up for this reason alone, even though standards of living rise while total population remains stable or declines.

The investor in Californian irrigation may well stand perplexed today, and indeed has had reason to view the future with uncertainty for nearly a decade. For the basically important assumptions no longer seem altogether safe. The experts in demography anticipate stability or decline of population either shortly or within a few decades, both in the United States and in many countries of Western Europe. The world is widely engaged either in destruction of capital in warfare, or in diversion of capital to uses (armaments) that in the long run do not promote the consumption of goods and services by the masses of people. Barriers to trade, which in themselves hamper international division of labor and therefore the general productivity of labor, are perhaps more prominent than they have been since the early days of the industrial revolution. Nations have tended internally—the United States among them—to substitute planned direction of economic activity for the free flow of capital and labor to the occupations which individuals might choose. The case in favor of such planning and direction, sometimes involving downright regimentation, remains to be proved by experience. It is not proved by the developments in Russia, Germany, or Italy.

If the agriculture of California is to retain or further emphasize the features that now distinguish it from the agricultures of regions with sister climates, that doubt needs to be resolved. The agricultural distinction of California does not rest fundamentally upon the climate, but upon the actions of men. Climate is passive or permissive; economic forces, largely man-made, are active and determining. It is not at all absurd, in the present state of the world, to say that the agricultural distinction of California might be lost within not many decades. Whether or not it will be lost probably depends as much upon the maintenance of a remunerative market as upon any other single influence. Today perhaps more than ever before, it is a major concern of forward-looking Californians to try to differentiate between the manifold national

and international economic policies that have been adopted or are under discussion. To put the matter bluntly, a world and a nation characterized by peace, free trade, and free competition is peculiarly important to Californians, because that is the sort of world that in the long run develops widening and remunerative markets for the expensive Californian agricultural products.

Note: Adapted with minor alterations from a paper presented to the Symposium on Climate and Man, Pacific Division of the American Association for the Advancement of Science, San Diego, California, June 21, 1938.

GEOGRAPHY OF THE FIBER-FLAX INDUSTRY

Aage H. Kampp

FLAX was probably the first plant cultivated for any other purpose than human food. Egyptian mummies are wrapped in flax fiber, probably *Linum usitatissimum L.*, and in the Swiss and South German pile-villages the flax discovered in the garments of the folk is *Linum angustifolium Huds.*

It may be supposed that *Linum usitatissimum* which, in a number of varieties, is the flax fiber plant of today, was originally found in the eastern Mediterranean zone, and was spread thence over the whole of Europe, Russia included, where for centuries it has found its chief center of production.

When, through its cheapness, cotton displaced flax in several regions, and furthermore, when economic conditions changed, self-subsistence lost its original dominance in the economy, the growing of flax declined or completely disappeared. It continued vigorous only in special areas of the flax industry, and in eastern Europe where self-subsistence and home industry continued to flourish. Beyond such areas, flax several times regained its prominence by efforts toward self-subsistence in regions which still support flax-growing in Europe, outside of the Soviet Union (Figure 1).

Despite increased use of linen thread in recent years, continued progress in the flax areas of the world will, on the whole, probably depend upon improved and, in particular, cheaper technique. The cultivation and processing of flax still demands excessive manual labor, but because flax fiber is extremely long, supple, strong, and durable, and more raw material per acre unit can be produced than is the case with, for instance, cotton of which the period of growth is substantially longer, the industry is not likely to disappear.

Physical-Geographical Conditions for the Growing of Flax

Given favorable climatic conditions, the nature of the soil plays an inconsiderable rôle, but flax thrives best in a light clayey or mellow sandy soil with sufficient and easily accessible nutriment. The sub-soil must not be too dry, but on the other hand it must be well drained, so that the water table lies deeper than the roots of the flax penetrate; it is preferable that the P-H ratio should lie between 6.5 to 7.

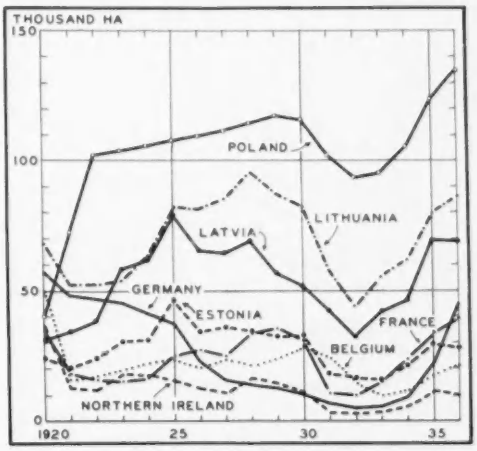

FIGURE 1.—A quantitative comparison of the relative importance of the textile flax areas of the several countries of north central and northwestern Europe, showing rise and fall in significance since 1920.

Flax thrives best in a rather moist, temperate climate, and the fiber seems of highest quality in a windy, oceanic climate. The plant is not well able to stand night frost below 3 to 4 degrees C., but as its period of growth is short (70

FIGURE 2.—Textile flax areas of the world, showing dominance of the U.S.S.R.

to 200 days) and the consumption of heat small (temperature total 1600 to 1800 degrees C.), it embraces wide range of territory in cultivation; in Finland the northern boundary is given as 63 degrees N. The rainfall should be about 12 cm. and fairly evenly distributed over the chief period of growth. Higher rainfall causes excessive branching.

LOCALIZATION TODAY

The world's most important spinning-flax areas embrace parts of the Union of Socialist Soviet Republics, and bordering European countries. In the U.S.S.R., which supplies about four-fifths of the world's production, and exports the largest quantity, the most important districts lie in the central and western parts of the country. About 85 per cent of U.S.S.R. flax is grown in the districts of Kalinin, Moscow, Leningrad, west and north Ivanovo, Gorky, and White Russia.

In 1932, the first year of the second five-year plan, about 2.5 million ha in the U.S.S.R. were sown with flax, and 2.2 million ha are projected for 1937.

The production of fiber has, for many years, been in the vicinity of one-half million tons, of which, in the course of time, about one-half has come to be used for industrial purposes in the U.S.S.R. itself. The flax industry was formerly concentrated in the Ivanovo district, but in the course of the second five-year plan, linen mills with just as great capacity as the mills in Ivanovo

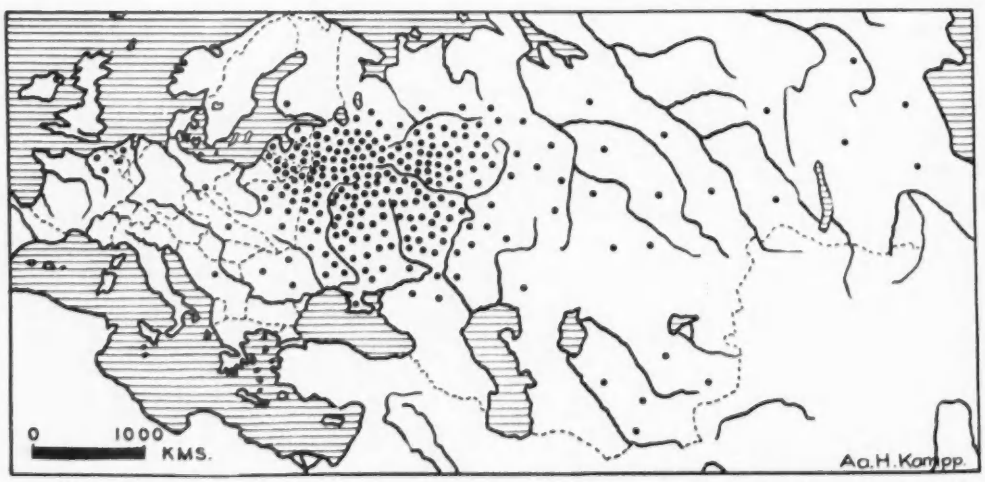

FIGURE 3.—Distribution of fiber-flax production throughout Urasia, with each dot representing 10,000 ha of cultivation. The only other region of import is Japan, for which the area of cultivation, as indicated by the last figures available in 1933, includes 13,000 ha.

will be erected in the western areas and in White Russia.

Leningrad is by far the most important export harbor, Murmansk coming second. Belgium is the most important consumer, after which comes Germany; but the British Isles, and countries neighboring the Union toward the west consume considerable quantities.

Poland is, after Russia, the world's next important flax-growing state. In the Vilno area, which formerly belonged to Lithuania, flax is the chief source of

FIGURE 4.—A great deal of flax is produced in the eastern half of Poland, and some throughout most of her territory. Each dot represents 50 ha of cultivated flaxland.

income for the population. About one-half the export has gone to Czechoslovakia. Germany, Latvia, and Belgium play somewhat smaller rôles as consumers.

In Lithuania, the part of the country bordering on the Vilno District devotes the largest area to flax production, and grows the best flax. The export of flax has been diminishing, and it appears as if the export possibilities of dairy and meat produce have been the decisive factor in reducing the quantities of flax exported. In 1934, the flax export

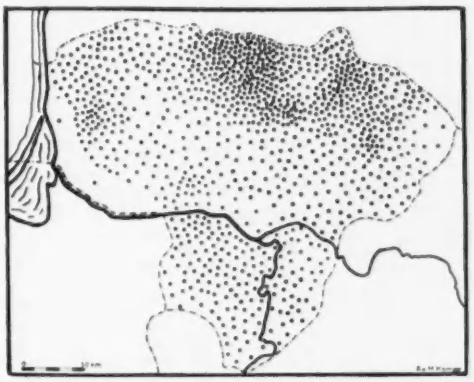

FIGURE 5.—Production of fiber-flax is rather generally distributed over Lithuania, with an area of maximum production in the north central section. Each dot represents 50 ha.

of Lithuania was not at all systematized, and the price of Lithuanian flax was appreciably lower than that of neighboring countries, but now the differential has been considerably adjusted. Before the war, the textile industry was scarcely represented, but now it is growing.

Two-thirds of the flax of Latvia is grown in the eastern province, Latgale. Generally more than one-third of the fiber production of the country is exported. The export of flax, however, now comprises a far lower percentage of the total export than was the case fifteen years ago. The greater part is exported through the flax monopoly administration of the state, by which

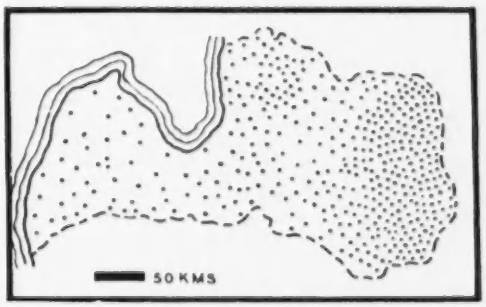

FIGURE 6.—In Latvia textile flax production is concentrated on the eastern border, but extends less significantly over the whole of the country. Each dot represents 50 ha.

the market price is not so largely subsidized as formerly, with the consequence that private firms have been able to work up a considerable export during recent years. Formerly Belgium was the greatest consumer (transit to France taken into account), but now the British Isles, Germany, and Belgium, and until recently Czechoslovakia have been the more important consumers. Before the World War there was a considerable linen industry especially in Riga, but the mills were destroyed. Now the industry has revived, which, however, must be content with the limited Latvian markets and which, instead of a few large mills, is represented by many small industrial enterprises.

In Esthonia the growing of flax is notably concentrated toward the south. As in the two countries previously mentioned, the industry is suffering from reduced market resulting from separation from Russia. The most important trading centers for flax are Pärnu, Tartu, and Tallinn.

In Germany and former Czechoslovakia the highly developed linen industry is supplied with imported flax, compared with which the quantity of home-grown flax plays only a very small, though rapidly increasing rôle.

Holland, on the other hand, has a rather extensive export as compared with imports; it goes especially to Belgium. The area maintained for many years was about 14,000 to 15,000 ha but declined from 19,000 ha in 1929 to 1,995 ha in 1932, after which it again rose to 14,000 ha in 1936.

In Belgium flax is one of the most characteristic industrial plants, grown

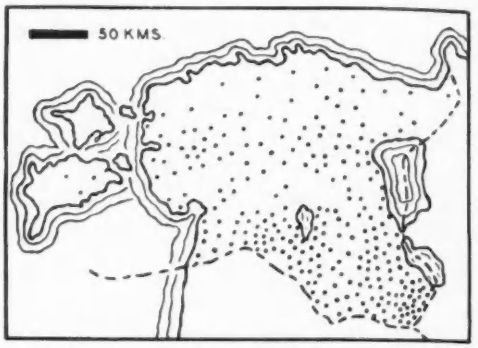

FIGURE 7.—The textile flax production of Esthonia is relatively small but rather well distributed though the southeastern section is most important. Each dot represents 50 ha of land in flax.

mainly in the valleys of Flanders. It is noteworthy that value of flax exported is greater than that of imports, while quantities in weight show the opposite. The predominant amount of the imports is, namely, flaxstraw (from France, U.S.S.R., Holland, and Latvia) while the exports are especially concerned with the partly worked-up flax, together with tow and waste (to Great Britain, France, and Germany).

The favorable geographical position and the superior Belgian manufacturing methods have made the Belgian flax industry famous throughout Europe and the world. It still plays a great rôle in the world's markets. Its chief seat is Flanders with the centers, Ghent and Courtrai. Belgium and Great Britain import the most flax.

The production of northern Ireland is far from adequate to furnish sufficient raw material for the mills of Belfast and the surrounding district; imports approach ten times the quantity of the home production, and come mainly from the U.S.S.R.

LAND FORMS, SETTLEMENT, AND LAND UTILIZATION IN THE SOUTHERN ALLGÄU

A. F. A. Mutton and A. E. Adams

THE small town of Füssen, in southern Swabia, lies on the left bank of the Lech, at the point where the river swings out of its mountain tract through the western Tirol on to the Bavarian Foreland. It is the regional center of two sharply contrasted types of country and the name *Allgäu* itself suggests a district located on the margin of highland and lowland. (Compare the Breisgau, Sundgau, and Kraichgau in the Rhine rift valley.)

Physiographic Background

Immediately to the south of Füssen the sheer edge of the calcareous pre-Alps rises to 4,000 or 5,000 feet, a group of peaks of jagged outline attaining over 6,000 feet in the Säuling, with Tegelbergkopf (1,567 meters) and the Branderschrofen (1,881 meters) forming subsidiary heights. While this range, the Allgäu Alps, carries the divide between Swabia and German-Austria, it is the parallel range trending ENE–WSW, the Lechtaler Alps of the Tirol, which, when continued eastwards as the Wetterstein Gebirge, culminates in the Zugspitze (2,963 meters). To the northeast of Füssen the Alpine buttresses curve away and their wall-like character is less apparent than, for instance, behind Oberammergau. In this strip, the sharp ascent is broken by a faulted foothill belt, developed on *flysch* (Tertiary conglomerate) which weathers into flat-topped, steep-sided, grass-covered hills, known as the Hohe Trauchberg (Figure 1). The continuity of the ranges is, moreover, broken by the transverse valley of the Lech, and by its obsequent tributary, the Vils, which enters from the west. In fact, the mile wide trough of the Vils severs the main mass of the Alps (represented here by the Tannheimer group of peaks, rising to 1,887 meters in the Aggenstein) from a narrow outlying ridge of Triassic limestone to the north. This ridge, known as the Vilsberg and the Weissenberg, also divides part of the Allgäu from the western Tirol. The main valley of the Lech contrasts with the structural trough of the Vils, although both appear to have been overdeepened by ice. The Lech, as it has worn a transverse valley across the east-west line of the Alpine folds, narrows and widens alternately as it has cut a narrow defile (in places only one-eighth of a mile wide, as at the Knie pass) through resistant bands of limestone, widening out into a broad drift-covered basin, as at Reutte, where the soft marls have been easily eroded. These basins, illus-

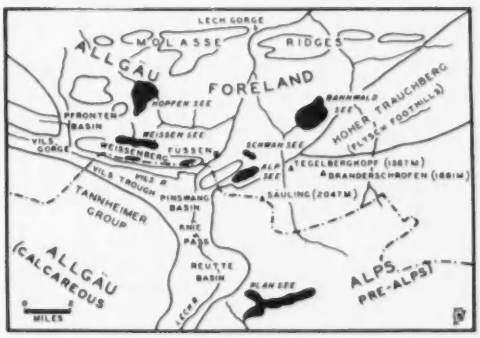

FIGURE 1.—Subregions of the southeastern Allgäu. Füssen lies on the threshold of the Allgäu Alps, at a point where the Lech Valley provides one of the main lines of approach to the western Tirol. To the north the dissected plateau of the Alpine Foreland, with its drift-dammed glacial lakes and peaty depressions, is diversified by the east-west line of Molasse hills. Flysch forms the foothill zone to the east of the Lech Valley.

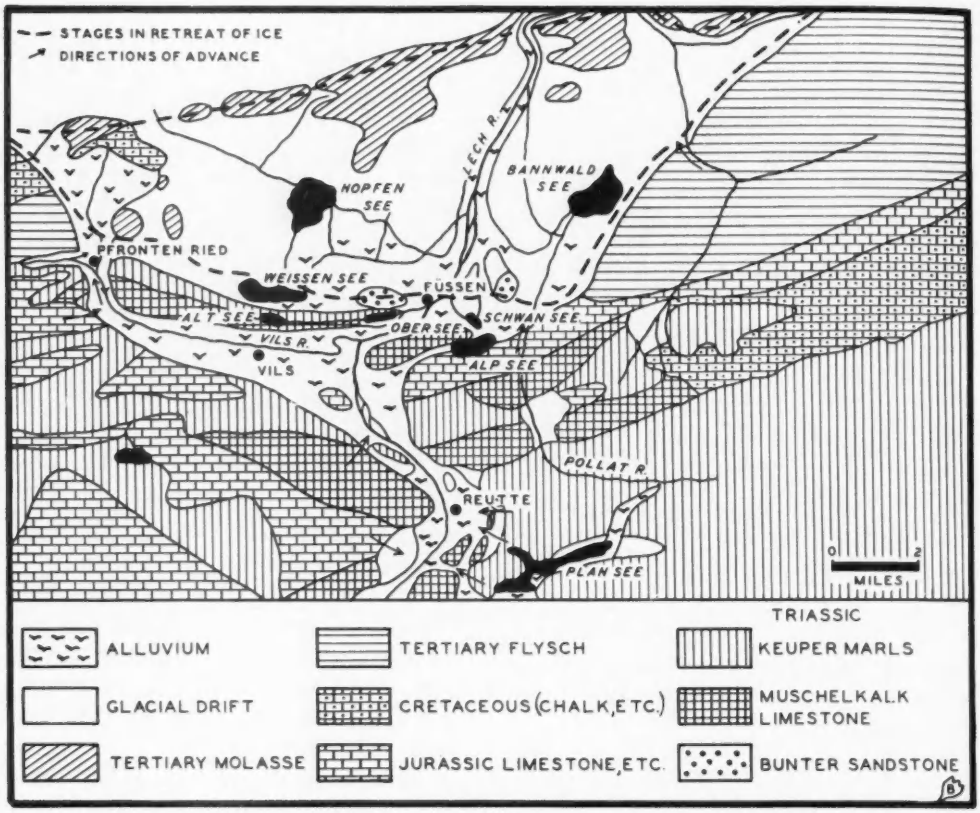

FIGURE 2.—Morphology of the district around Füssen and southeastern Allgäu. The subregions of Figure 1 are reflected in the complexity of rock structure underlying the middle Lech basin. In the zone of the Pre-Alps the mountain masses are composed of Jurassic and Triassic limestones with bands of Keuper marl often forming intermediate depressions. In the Foreland Molasse comes to the surface in a line of hills north of the lake belt, through which the Lech cuts a miniature gorge. Glacial drift is widespread and extends up the valley of the Lech and its tributaries.

trated in Figure 8, are flooded by the river coming down in spate in spring, whereas in summer it maintains a shrunken, braided channel. They are the main foci of settlement, the forest having long given way to rich meadow land, excellent for cattle, and to a rather limited amount of arable land owing to the constantly high water-table. It is also characteristic of the Alpine streams that before they emerge on to the Foreland, their last section is through a deep gorge cut into the outer band of limestone. The Vils, Lech, and Pöllat all show this feature, and the last two have falls and rapids here.

The Alpine background of the Füssen region, as part of the outermost ripples of the Tertiary folding, is developed on highly folded and contorted Mesozoic sediments. These have been differentially eroded in such a way that the *Muschelkalk* (shelly Triassic limestone) and the Jurassic limestones form the ribs, as it were, of the mountain structure, while softer Keuper marls have been preserved in the intervening troughs. Cretaceous rocks also occur as outlying *Klippen* to the north of the Vils gorge and to the east of the Säuling. Within the Alps, the grandeur of the bare limestone rock faces and the beauty of the pine forests mantling the mountain slopes, are further enhanced by the

occurrence of a number of glacial lakes, which often lie embedded in deep and largely hidden valleys. The Plan See, with its scree margins, to the east of Reutte, compares in its remoteness and splendor with the English Wastwater. Smaller lakes, within easy reach of Füssen, and consequently much more frequented by tourists, are the Alt and Ober See, deep sunk in the Weissenberg ridge, and the Schwan and Alp See to the east, close to the fantastic castles of Neuschwanstein and Hohenschwangau.

To the north of the Alps, the Foreland presents the appearance of comparative monotony, varied by a narrow ridge of *Molasse* hills, which rise at the most to little over 3,000 feet, that is, only about 500 feet above the general level of the Foreland, and through which the Lech cuts a miniature gorge. Here, as the result of a local flexure, the Tertiary rocks pierce the skin of the overlying drift, which elsewhere covers the Foreland to varying depths. In places the boulder clay has been heaped up into hummocky ridges and mounds, but definite moraines are not so apparent as farther down the Lech valley, where great ridges parallel it on both sides. The general appearance of the Allgäu Foreland is, therefore, that of broken country, with no very definite drainage pattern—the piles of drift forming local water partings. The presence of much ground moraine accounts for the large number of marshes and the occurrence of peat bogs, not yet reclaimed, and, together with the prevalent birch-heath vegetation, are further relics of the Arctic conditions which prevailed after the retreat of the ice. In the stony bed of the Lech, dwarf willow scrub is widespread, and here also *Dryas octopetala* and gentians are to be found. Three glacial lakes lie wedged between the foot of the Alps and the drift dumps to the north; they are the Hopfen, Weissen, and Bannwald lakes, all of which are steadily shrinking in area, as the encroachment of reeds around their margins indicates.

EVOLUTION OF SETTLEMENT

Although the rivers of the Foreland have provided lines of movement and penetration from prehistoric times to the present, the southern Allgäu contrasts with the northern region, adjacent to the Danube, in its comparative lateness of settlement and its comparatively thin spread of rural population (averaging between 60 and 80 to the square kilometer). As part of the Roman province of Rhaetia, the region lay athwart a main route linking northern Italy via the Fern pass and the Lech valley with Augsburg (Augusta Vin-

FIGURE 3.—The Säuling (2,098 meters), a peak on the boundary between Swabia and the Tirol, south of Füssen, showing Muschelkalk formation.

FIGURE 4.—The Zugspitze (2,963 meters), with forests of Austrian pine in the middle distance.

delicorum). Consequently, a number of settlements, such as Kempten and Kaufbeuren, date from the Roman period of occupation, and these later developed into Medieval trading centers.

The chief basis of existing rural settlement, however, dates from the establishment of homesteads by the Allemanni tribes from the third century onwards. These early settlers showed a preference for dry, open heathlands, associated especially with the light, tractable loess terrains bordering the

FIGURE 5.—An isolated basin up the Vils Valley in the Tirol. The forest has been cleared so as to provide meadow for grazing. Hay barn on the right. Jungholz is the nearest village, and the basin is isolated by the enclosing forested mountain slopes.

Danube, and also with the morainic ridges. The abundance of "early" place name endings, such as "-heim" and "-ing," in the northern Foreland, contrasts with the number of later "-ried," "-reut," and "-moos" endings to be found in the South. A further related feature is the large proportion of arable cultivation in the more thickly populated North, compared with the predominance of pasture land and stock rearing in the relatively sparsely settled South. The southern Allgäu is pre-eminently a region of *Graswirtschaft* or a grazing economy. With this type of land use may be associated the large number of single, isolated farmsteads (the "Einzelhöfe" of the Allemanni) and the occasional hamlets (denoted by the "-weiler" place name ending). At the foot of the Alps, a third type of settlement sometimes appears, that of the chain village ("Kettendorf") of which Pfronten-Ried and Pfronten-Weissbach, etc., on the Vils, are examples.

The later Middle Ages were associated with further clearance of the forest and scrub for arable and pasture land, especially through the establishment of monastic houses in the region, between the eleventh and twelfth centuries, for example, by St. Mang in Füssen. Late forest clearing settlements are indicated by such suffixes as "-schwend," "-brand," "-ried," and "-reute." These endings are especially abundant in the western Tirol, where the process of forest clearance for settlement may still be said to be in progress. Figure 5 illustrates an isolated basin above the Vils gorge where the trees have recently been cut to provide pasture for cattle grazing. This process, whereby the trees are only cut down to stumps and not uprooted, is known as *Hackwaldwirtschaft*.

FIGURE 6.—The Lech at Füssen, showing the regulated river, the old part of the town on the left bank, and the Weissenberg ridge in the distance.

Füssen, owing to its location on a Medieval salt road, at the junction of the timbered and mineralized region of the Alps and the pastoral foreland, developed as a market center. Further,

its site on a steep bluff above the Lech provided a suitable position for a castle commanding the approach to the defile above the town, which was followed by the main road already mentioned leading via the Arlberg to Milan and north Italy, with a branch striking off from Reutte for the Engadine and Innsbruck over the Fern pass. Today, apart from its rope works employing 2,000 people and deriving hydro-electric power from the Lech, the town of Füssen is mainly concerned with seasonal tourists, in the same way as Garmisch-Partenkirchen, Mittenwald, Oberammergau and, less well-known, Oberstdorf.

The western Tirol is especially noted for the retarded development of its natural and agricultural resources, and this is partly to be explained by the way in which the German-Austrian frontier formerly cut across the natural outlets for the produce of the Tirol by means of the transverse valley routes. A region of surplus foodstuffs, especially dairy produce, stands isolated by a long mountain barrier from the main center of deficiency in Austria; Vienna. Further, little attempt has been made to develop the forest resources of the Allgäu and Lechtaler Alps. A few saw mills are to be found at intervals up the Lech and Vils valleys, using water power from the streams. The only large establishments, apart from the rope works at Füssen, are a cement works opposite Vils, and a precise instrument factory at Pfronten. The main concern of the peasant of the Allgäu and the western Tirol, as is described later, is with subsistence farming and the production of a small surplus of dairy produce etc. for nearby villages and tourist centers. The standard of livelihood is low, and, to judge by the unkempt nature of most of the Tirolean farmsteads, is not improving.

FIGURE 7.—View of Pfronten, in the Vils Valley, showing method of drying hay on cross bars (Heinzen).

FIGURE 8.—Reutte, in the Lech Valley of the Tirol, showing basin site. The town is surrounded by strips of cultivation and meadow land. The gorge cut by the Lech through the Lechtaler Alps is shown in the middle distance; it is followed by the road leading to the Arlberg.

LAND UTILIZATION

This part of Germany is remarkable for the high proportion of land under forest (mainly coniferous), waste, and meadow: there is very little under arable cultivation. The generally excessive rainfall, together with the predominance of gray-brown, podsolized soils favored an original forest vegetation of which extensive tracts remain. The trees typical of the forested areas are the Austrian pine on the steepest slopes and poorest soils, Scots fir, spruce, and larch, and there are scattered yew, ash, and maple trees. The beech is the most widespread deciduous tree and is found at lower altitudes, especially on well-aerated soils, but the oak is rare as it needs more light and cannot compete with the quicker growing beech.

The Allgäu Alps. Forests interspersed with Alpine meadows and barren slopes occupy the mountain belt to the south of Füssen, but wood-cutting appears to be, on the whole, unimportant. The Lech is no longer used for floating timber, and road and railway communications only skirt the forested area. However, saw mills are at work in the upper Vils valley, near Neuschwanstein, along the Halblech valley, and near Heiterwang. In the Füssen district, the only evidence of woodworking is the making of wooden pails and lard tubs, and there is a paper mill at Schöngau. The former lute and fiddle making industry has disappeared.

Almen or mountain pastures are unimportant in the Allgäu. They are composed of a variety of meadow grasses, some of which are detrimental to cattle. They also include much heather, dwarf willow, and dwarf pine. Cattle if sent to the *Almen* are always store or young cattle, and the practice of transhumance is not usual in the Allgäu. Mowing for hay is general throughout the region.

The Allgäu Foreland. The southern belt of the Alpine Foreland in Swabia is a grazing and cropping region. The richness of the meadows is further in-

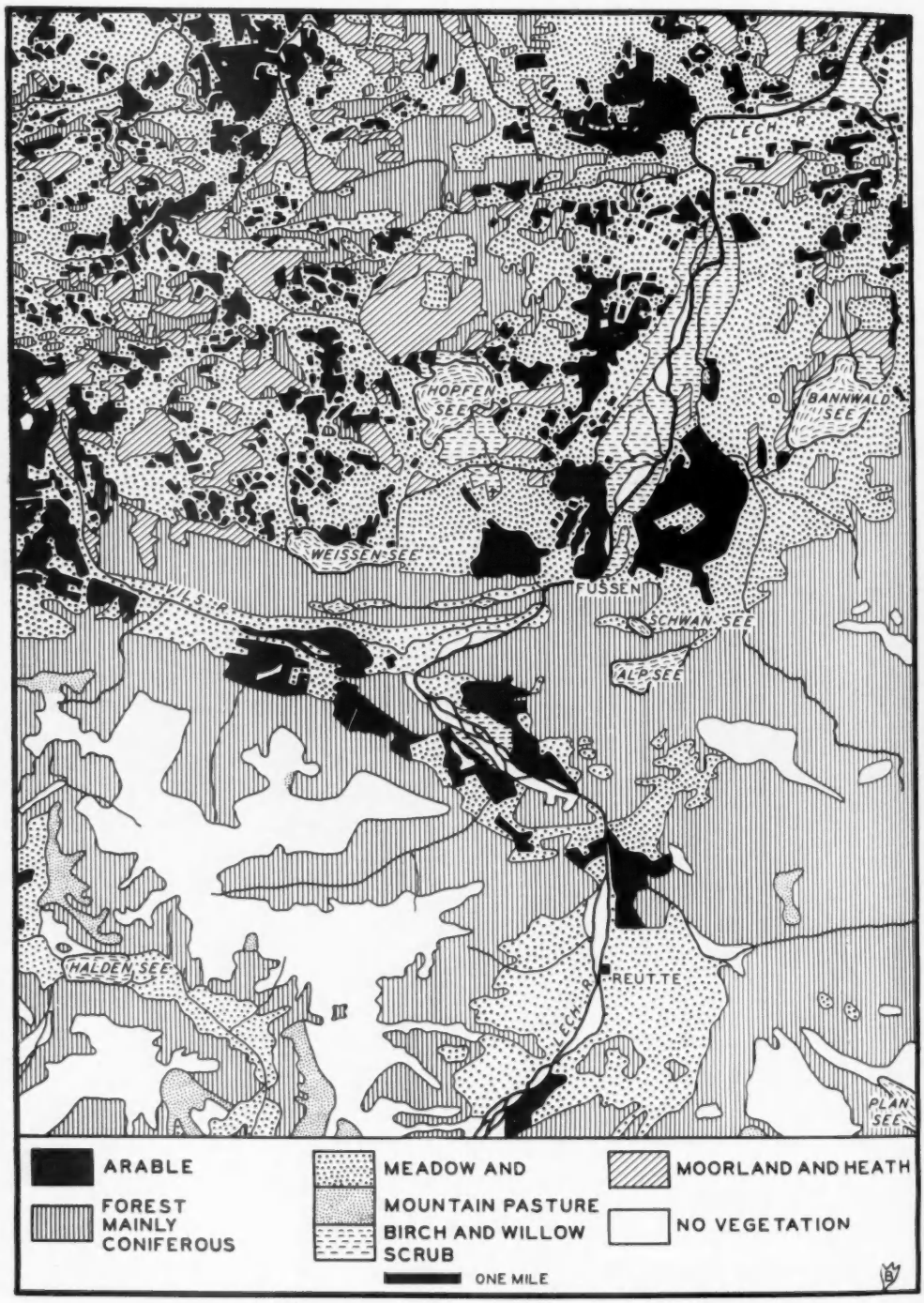

FIGURE 9.—The land utilization map is a striking reflection of the human response to a variety of physical factors—land forms, climate, soils, etc., in the borderland between the western Tirol and southern Swabia. The two contrasted regions of the Pre-Alps, with their pine forests and mountain pasture, and the pastoral and arable Foreland are evident. The latter region presents the most complex pattern of land use, further diversified by strips of forest, mainly coniferous, corresponding to the Molasse ridges and the morainic hills.

creased by the application, wherever practicable, of liquid manure and chemical fertilizers; and the quality of the grass has notably improved during the present century. Mowing takes place two or three times a year and is very laborious, involving family hand labor. The grass is dried on poles with three cross bars, *Heinzen*, and is then stored in wooden huts. A small farmer with ten cows will own perhaps a thousand of these *Heinzen*. The typical dairy product is the round cheese of the Allgäu, usually made in a brick building with a tiled floor, the cheese being heated in a copper pan before an open fire. Soft cheese and other kinds containing less fat are made as the season progresses, the skim being fed to pigs. Other milk products of the Allgäu, some of which find an export market, are dried and condensed milk, and ultracine. The modernizing of the dairying industry has meant instruction, inspection, and publicity in regard to Allgäu dairy products, and even in the western Tirol there are dairy schools and cattle rearing associations.

In the areas best adapted to cultivation in early historic times the woods must have appeared as islands in open agricultural country, but even the most suitable areas for cropping on account of topography and soils have always suffered from climatic disadvantages for cereal and fruit cultivation. The growing season is short, lasting from the end of April until the end of September, and the rainfall comes chiefly in summer in the form of convectional storms. West of the Lech, a form of wheat known as spelt or *Dinkel* is common, but the better types of wheat are found on the loess areas. Barley, rye, and oats are also grown, but in small quantities, the oats being chiefly for

FIGURE 10.—The edge of the Allgäu Alps and the Foreland. The Weissen Sea, blocked by the Alpine wall to the south and morainic drift to the north, lies in the center, with the regulated Lech in the distance. Pine forests mantle the mountain slopes and patches of woodland alternating with meadow and a few strips of arable land appear on the Foreland.

winter feed and straw. The region appears to be suitable for sugar beet, but little is grown; and the cultivation of flax has not responded much to recent artificial stimulus. Potatoes, grown on light soils, give a poor return, but fodder plants, including various types of clover, are cultivated everywhere. There is little fruit culture, and no production of field vegetables. In general, it may be concluded that the southern Allgäu is unsuited to arable farming, which, since the improvements in transport in the last century, has declined in favor of dairying.

One system of cultivation makes it difficult to distinguish between arable and meadow land. It is that of *Egartenwirtschaft*, whereby the land is maintained under grass for several years, then ploughed for the rotation of crops for several seasons, until a reversion to grass is made. In the districts least suited to cereal cultivation, the ratio of years under grass to years under crop rotation may be 15 : 3; and, in general, wherever this system is adopted, the arable land is subordinate to the meadow, the years devoted to crop rotation having the effect of improving the soil for meadow.

In addition to the areas marked on the map (Figure 9) as meadow or mountain pasture, the moors, occurring chiefly on infilled glacial lakes in the morainic foreland zone, come into use for grazing and mowing, if there is any part of the year when they can be trodden by cattle. These areas are relics of former common land and have been in use since early times. Peat cutting and the mowing of coarse moorland grasses eventually transforms these waste lands into meadows. Peat is still cut locally and dried for winter fuel, but the steady reclamation of these tracts is reflected in their gradual decrease in extent.

THE UPPER THRACIAN PLAIN IN BULGARIAN AGRICULTURE

Anastas Beshkov

THE broad valley of the Maritsa River forms the large lowland plain of Upper Thracia which extends east-west between the Rhodope Mountains and Sredna Gora and slopes gradually and almost imperceptibly from elevations of 100 to 200 meters eastward and east-southeastward. The Upper Thracian plain, a structural feature formed in the beginning of the Pliocene, is delimited on the north by a fold and on the south by a series of faults. The hills of Plovdiv (Philippopolis) are erosion remnants of a peneplain which has sunk, and after the sinking has been overlayed with sediments, thus assuming the character of a real plain. The process continues even at present, as is indicated by the earthquakes of 1928, and the absence of old diluvial terraces. As a result, the landscape reveals every aspect of a typical lowland plain—such an area as provides fundamental conditions requisite for easy irrigation.

The plain of Upper Thracia has excellent soil for varied crop production. Loose and mellow alluvium characterizes the river flats, but elsewhere black earth, or chernozem, has developed over the area, which approximates 7,500 kilometers in extent, almost 7½ per cent of the whole area of Bulgaria. The proportion of cultivated land is substantially higher than in other parts of the country.

The climate of the region is distinguished by a favorable positive anomaly of temperature with the result that frost in springtime or autumn rarely damages growth. The growing season is defined in accordance with Table I.

The precipitation is not adequate for normal agriculture. The valley lies within a horseshoe-shaped depression encircled by elevations high enough to condense most of the moisture, leaving the valley within the rain shadow. The precipitation for the whole of Bulgaria is 65 centimeters annually, whereas in the Upper Thracian plain it averages only 50 to 55 centimeters. The inadequacy of moisture may be compensated for in large part by irrigation, for which the conditions are so favorable. Table II showing drought indices

TABLE I

FROST DATA FOR NINE STATIONS IN BULGARIA

Stations	*Average Date*		*Last Frost Latest Date*	*First Frost Earliest Date*
	Last Frost	*First Frost*		
Sliven	Mar. 30	Nov. 19	May 7, 1915	Oct. 28, 1912
Stara Zagora	Mar. 26	Nov. 17	Apr. 24, 1902	Oct. 22, 1903
Haskovo	Apr. 10	Oct. 28	May 6, 1915	Sept. 25, 1902
Sadovo	Apr. 4	Nov 2	Apr. 27, 1896	Sept. 24, 1902
Plovdiv	Mar. 24	Nov. 7	Apr. 25, 1912	Oct. 19, 1911
Pazardjik	Apr. 8	Nov. 4	May 5, 1914	Oct. 8, 1914
*OC. Chiflik	Apr. 8	Nov. 1	May 7, 1915	Oct. 12, 1908
*Shumen	Apr. 11	Oct. 29	May 10, 1909	Sept. 27, 1906
*Pleven	Apr. 3	Nov. 3	May 22, 1903	Sept. 24, 1902

*North Bulgaria.

TABLE II

INDICES OF DROUGHT

Station	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Aver. Annual	1–12
Stara Zagora	40	32	29	26	28	30	24	22	16	20	36	38	26	28
Haskovo	73	45	38	22	21	30	19	14	19	22	49	48	28	34
Sadovo	53	39	30	22	22	27	21	12	18	21	42	34	25	28
Plovdiv	40	29	27	21	26	24	19	15	16	20	36	32	23	26
Pazardjik	45	29	29	32	21	23	18	11	15	23	28	31	22	24

derived by De Martonne's formula, in which I = P: (T + 1) and P represents the aggregate annual rainfall in millimeters, T represents the median temperature of the year in centigrades (Celsius), is illuminating.

Martonne classifies a climate with an index less than 20 as arid. Though the index for the year in the Upper Thracian plain never falls below 20, the monthly index for the growth period generally falls below 20 and may even fall below 15.

No other section of Bulgaria is so significantly affected by the hydrography as is the plain of Upper Thracia, which lies wholly within the drainage basin of the Maritsa river. The water of the Maritsa is derived from tributaries issuing from the Rhodope Mountains and yielding a volume of 50 cu. meters per second. Strange to say, the quantity of water in the lower Maritsa is as great as that in the upper Maritsa, despite the high evaporation and the considerable distance that the Maritsa traverses, and the use of a great deal of the water along the course of the river in the irrigation of rice fields, meadows, and vegetable gardens. Consequently it is evident that the plain of Upper Thracia is not appreciably irrigated from the Maritsa river. The comparison, which is often made, between the plain of Upper Thracia and the lowland of Lombardy must take into

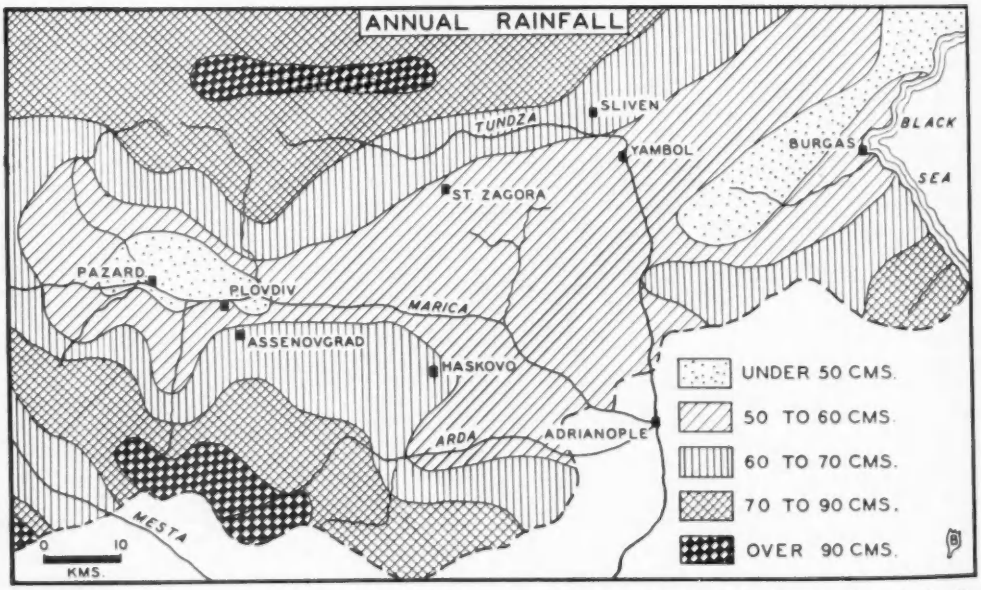

FIGURE 1.—The relative semi-aridity of the mountain-enclosed plain of Upper Thracia is disclosed by the distribution of the average annual rainfall.

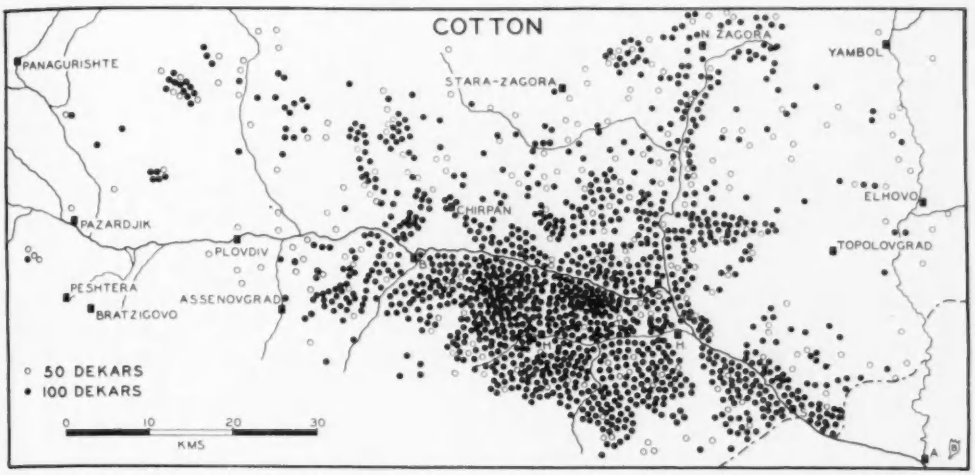

FIGURE 2.—The production of cotton in the Upper Thracian plain could be materially increased by the development of a modern system of irrigation, utilizing the water supply available in the Maritsa river system.

account the fact that whereas there is similarity in general between the two areas there is an essential difference in precipitation, which makes the comparison relatively invalid so far as crop production is concerned. With an average temperature of 13 degrees C., the Lombardy lowland enjoys an average precipitation of about 100 mm. annually, whereas the plain of Upper Thracia with almost the same average annual temperature, 12½ degrees C., receives an annual average of only 530 mm. Applying Martonne's formula as follows:

The Lombard Lowland: I = 1000: (13 + 10) = 43.5
Upper Thracian Plain: I = 530: (12.5 + 10) = 23.5

it is evident that the plain of Upper Thracia must be considered semi-arid, necessitating for crop production a carefully planned and well organized system of irrigation, if agriculture is to be profitable and successful. Such a system would increase the area of successfully irrigated land from 8,000 ha to 130,000 ha. An expenditure of not more than $150,000,000 would provide such a system, and this could be repaid in due time by taxes upon the use of water. Not only would the monetary return upon the investment justify such an expenditure, but the social advantages accruing from the project would more than warrant it.

PLACE OF THE UPPER THRACIAN PLAIN IN BULGARIAN ECONOMY

The rôle of the plain of Upper Thracia in the economic system of Bulgaria can be determined only by a careful analysis of the conditions in the plain in relation to those of the whole of Bulgaria. It is important: (1) to observe that the area of cultivated land in the plain of Upper Thracia constitutes 49½ per cent of the whole area, whereas the cultivated land of the whole of Bulgaria in proportion to the total area is only 40.3 per cent, a 9.5 per cent advantage in favor of Upper Thracia; (2) that while the density of population of Upper Thracia is 11 per cent greater than the density of population of the rest of Bulgaria, the average area available for each person engaged in agriculture is only

0.682 ha for the latter, whereas it is 0.726 ha for the former, a proportion of 100:94 in favor of Upper Thracia; (3) that the rental derived from the cultivated area is 6.71 per cent higher in Upper Thracia than in the rest of Bulgaria; (4) that, though the cultivation of plants for oil and other industrial purposes has become rather important, the method of production remains fairly primitive. (As an example, there is one threshing machine for every 300 ha of cultivated land in northwestern Bulgaria, whereas in Upper Thracia one threshing machine must serve from 2,000 to 3,000 ha, but this discrepancy is due not only to extreme conservatism in Upper Thracia, but to the fact that plans for oil and other industrial purposes require more work by hand); (5) the plain of Upper Thracia is no longer the most important granary of Bulgaria, as a consequence of the gradual replacement of cereals by plants for oil and industry and of the increase in population. The percentage of oil and other industrial plants produced in Upper Thracia in comparison with the whole of Bulgaria for the period between 1929–1933 is as follows:

TABLE III

PERCENTAGE OF BULGARIAN PRODUCTS FROM UPPER THRACIA

Tobacco	30.43	Fennel	62.62
Sugar beets	14.38	Anise	98.37
Sunflowers	20.42	Peanuts	90.35
Colza	3.57	Cotton	70.30
Poppy	8.28	Hemp	10.56
Sesamum	86.73	Flax	23.53

Since that period the area devoted to hemp, peanuts, and cotton has been extraordinarily expanded.

In view of the fact that the whole plain of Upper Thracia includes only a sixth of the total cultivated area of Bulgaria, the relative importance of the plain becomes clearly manifest. Though sunflowers, sugar beets, and colza have not expanded so much as the others, it is important to recall that they thrive more successfully in the north than in the south, and for the best interests of the country they should be abandoned in the south to provide more space for the cultivation of more valuable industrial plants, and cultivated more extensively in the north.

GARDENS, VINEYARDS, AND ORCHARDS

The important and highly developed truck gardening industry is based upon

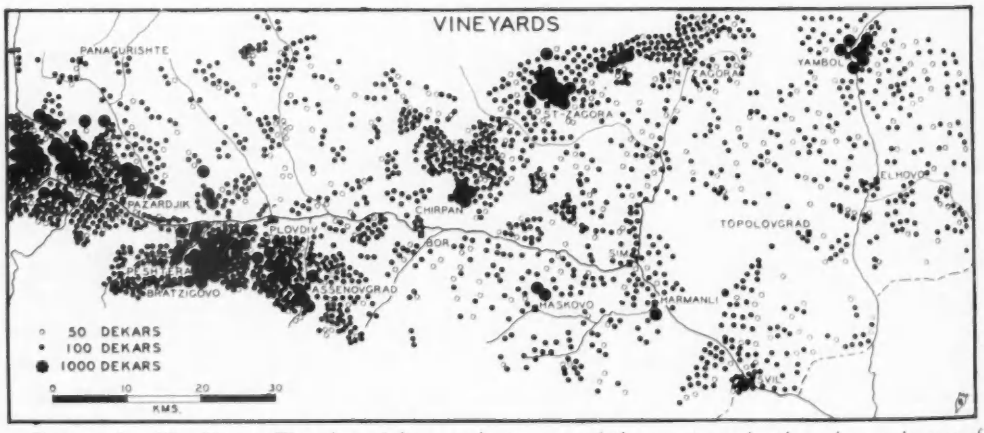

FIGURE 3.—The Upper Thracian plain constitutes one of the most productive vineyard areas of Bulgaria. Vineyards are rather generally distributed over the whole area.

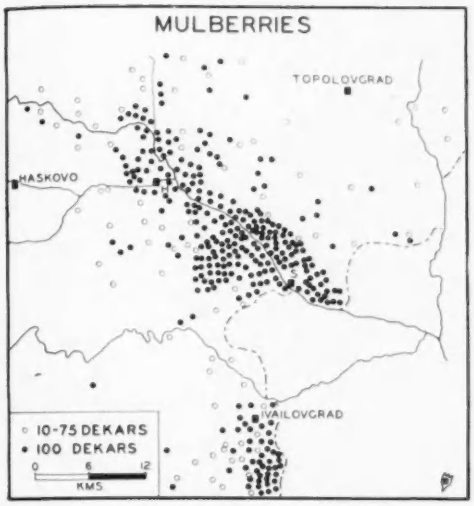

FIGURE 4.—Sericulture has become of essential value to the economy of Bulgaria, and the Upper Thracian plain plays an important rôle in the industry.

fertile soil, favorable seasons, and successful irrigation, as well as excellent transportation and high skill of the gardeners. Every year thousands of carloads of early vegetables are sent to Sofia and other towns of the country, and to foreign countries, mostly Germany. (Tomatoes, paprika, and tomato pulp are exported in large quantities.) The eastern part of the Upper Thracian plain is particularly noted for its canteloupes and watermelons. In the last decade the increase in horticulture in the north Bulgarian district has been 18 per cent, whereas in the south Bulgarian district it has increased 81 per cent.

Vineyards spread widely over the Upper Thracian plain, which provides 26 per cent of the total grape production of Bulgaria. The vineyards of Pazardjik and Chirpan grow grapes primarily for vintage, and the wines of the region are well known. The vineyards of southern Plovdiv grow the best dessert grapes. The total production of grapes in Bulgaria is annually about 400,000,000 kg., of which 36,000,000 kg. are exported, and of these 80 per cent are consigned directly to Germany, where they play an important rôle in the market. The early ripening varieties of Thracia are included within this export trade, though it is regulated by a very strict state control.

The Upper Thracian plain plays only an insignificant rôle in the cultivation of other fruits. Such notable orchards as may be included within the region lie chiefly in its periphery. Yet there is no reason why orchard fruits should not become much more important if irrigation to supply adequate water could be provided. Strawberries are very widely cultivated and great quantities of this delectable fruit are produced on the Upper Thracian plain wherever conditions for growing and ripening them advantageously prevail. In later years strawberries have not been exported fresh so much, but the export of strawberry pulp has materially increased, primarily to England and Germany.

The growing of mulberry trees for sericulture has expanded significantly, particularly in the southeastern portion—in the districts of Harmanli and Svilengrad, and in the remoter district of Evailovgrad. In these three districts are more mulberry gardens than in the other 87 districts of the section, and by far the greatest production of cocoons is ascribed to them.

Rose growing, almost monopolized by Bulgaria for the production of attar of roses, is developed chiefly in the basin south of the Balkan mountains and only to a limited extent in the northern part of the Upper Thracian plain.

Rice is produced in three different regions in Bulgaria—the valley of the Maritsa river, the valley of the Tundsha river near Yambol, and the valley of the Struma river. Of the three, the Maritsa river section, mostly the districts of Pazardjik and Plovdiv, in-

cludes 92 per cent of the area devoted to rice. Bulgarian rice is of good quality. In the recent past it has been exported chiefly to Czechoslovakia.

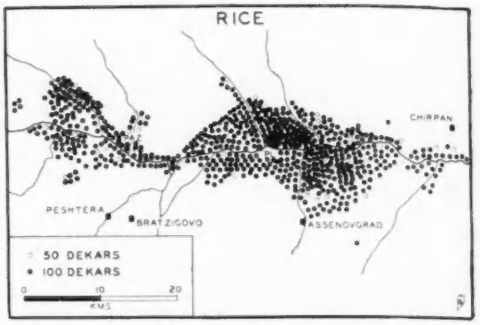

FIGURE 5.—Three districts grow most of the rice of Bulgaria—the valleys of the Maritsa, the Tunsha, and the Struma rivers—and of the three 92 per cent of the yield comes from the Maritsa valley. Bulgarian rice is of good quality. In recent years it has been exported chiefly to Czechoslovakia.

SUMMARY

Though the plain of Upper Thracia does not embrace as much as 10 per cent of the total area of Bulgaria, it occupies a position of great significance in the agricultural economy of the country. Its dominant position is indicated by the high percentages of its production as compared with the rest of the country as follows:

TABLE IV

UPPER THRACIAN SHARE OF BULGARIAN PRODUCTION

(*In Percentages*)

Grain	15.66	Potatoes	5.40
Oil and Industrial Plants	17.31	Vineyards	25.27
Vegetables	22.53	Mulberry Groves	73.54
Forage	11.11	Rose Gardens	22.31
		Orchards	7.43

The conclusion follows that except for potatoes and fruits, in which it is surpassed by other sections of the country, Upper Thracia leads Bulgaria in agricultural production. If a modern system of irrigation were provided to supplant the present primitive method, the position of the Upper Thracian plain would unquestionably become much higher—then really comparable with Lombardy in the value and quality of its products. Every experiment that has been made bears out such a conclusion.

BLOCK-PILE SYSTEM OF STATISTICAL MAPS

Erwin Raisz

SINCE Sten de Geer introduced his system of small spheres for the representation of the population of cities his method has gained great popularity in the United States. (See Sten de Geer: A map of the distribution of population in Sweden. *Geog. Rev.*, v. 12, 1922, pp. 72–83.) Spheres are now used not only on density of population maps, but also on maps of manufacturing and on statistical maps showing any highly concentrated variables. The system has many advantages but it has also so many imperfections that for its substitution the "block-pile" system is here recommended in the form described below.

To gain a better understanding of the value and limitations of the proposed system, a short summary of the other usual methods of statistical mapping seems to be necessary.

Statistical maps show the pattern of distribution of a single element in a quantitative way. Such typical distributions are: the density of population, amount of rainfall, value of economic production, etc. Soil, vegetation, and similar maps do not belong to this group because the variation is in type or quality rather than in quantity. The variation in quantity is expressed usually by four different methods:

1. *Isopleths.* Localities in which the statistical distribution has equal density, amount, or value are connected with lines at chosen intervals. The properties of isopleths can be best understood in considering the lines connecting places of equal altitude above sea level called isohypses, or more commonly, contour lines. Isopleths, like contour lines, express and demand exact information and are adapted to show variation which is rather continuously distributed over large areas like rainfall or temperature. They would not be adapted to show highly concentrated distributions such as manufacturing. The belts between isopleths are often differentiated by tints, the darkness of which should be in arithmetical proportion to the value represented. (J. K. Wright differentiates between "isarithms" and "isopleths"; the term isarithms being restricted to the maps which show *continuous* distribution, such as temperature or elevation above sea level. Elevation between the 20 and 40 contour lines is everywhere between 20 and 40 feet but it is not true that the density of population between the 20 and 40 isopleths is everywhere between 20 and 40 per sq. mile if we take into consideration very small areas. Here, however, since only methods are discussed, this differentiation is not followed through and the term "isopleth" is used for both conceptions.)

2. *Dot system.* The system shows by little dots the density of distribution of individual units, such as the number of farm animals or acreage of corn. Each dot represents a certain number of units and is placed in the "center of gravity" of these units. The size of dots is determined so that only at the densest places will the dots coalesce into a dark mass. Dot maps give a vivid impression of the pattern of distribution, but since dots cannot be easily counted they are used more often in educational maps than in works where exact numerical information is required. Dot maps, like isopleth maps, are not adapted to show extreme concentration of the variables as occurs in cities.

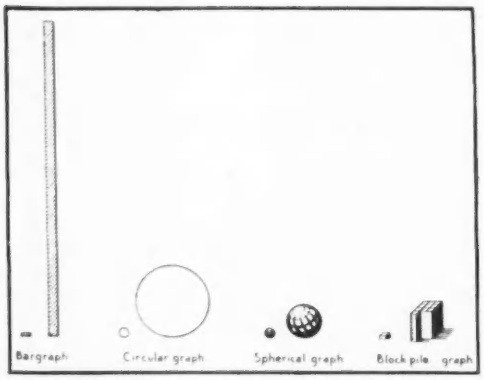

FIGURE 1.—Comparison of one, two, and three dimensional graphs each showing two quantities related as 1 to 100.

3. *Choropleth maps.* In these maps the density, value, or quantity of the variable is shown by tints or index numbers applied to certain local units for which statistical data are most often available. As data are usually assembled for political units, the most common are the maps in which townships, counties, or states are differently tinted. For these maps the term *Demopleth* maps is here proposed. Choropleth (demopleth) maps have the same limitations as isopleth maps.

4. *Maps with superimposed diagrams.* In these maps the distribution is expressed by placing small diagrams, line graphs, pie graphs, bar graphs, or other two- and three-dimensional graphs upon the maps. This method is used: (a) when the variable is subdivided; (b) when we want to show variation of the variable itself, as for instance, if we place small rainfall curves on the map at various localities; (c) if the variation is extremely concentrated in a few localities.

The first two requirements can be satisfied by almost any kind of graph and are not further discussed here but certain difficulties arise in the representation of highly concentrated distributions as in maps of manufacturing, mining, and density of population.

The chief difficulty lies in crowding too many symbols into the urban regions as the usual small-scale maps often require. Linear graphs like bar graphs and line graphs are the least economical in space. Two-dimensional graphs, pie graphs, or square graphs are better since here the diameter of the pie or the side of the square is proportionate to the *square* roots of the quantities involved. Most economical in space are the three-dimensional graphs, such as spheres or cubes, the linear extent of which is proportionate to the *cubic* root of the quantities. As applied to the map these are not really three-dimensional graphs but only the pictures of them which by strong shading give the impression of geometrical solids. Figure 1 shows how the size of one-, two-, and three-dimensional graphs compare if the quantities are related as 1 : 100.

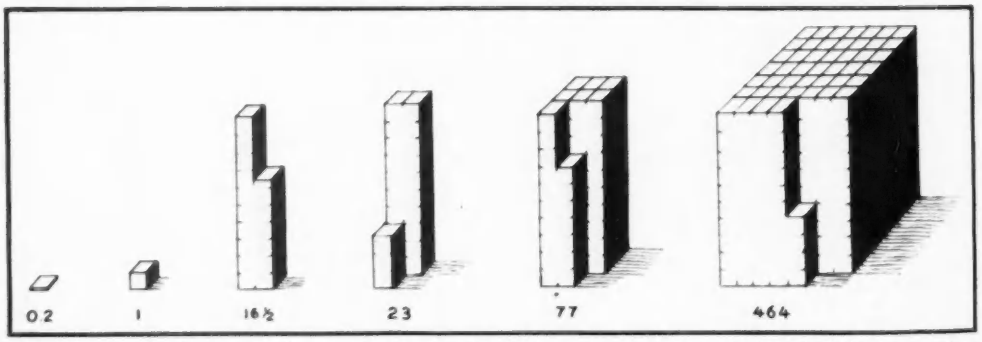

FIGURE 2.—In the block-pile system the unit-blocks and pillars are arranged so that the incomplete pillars are always in front.

Even more striking is the difference between the smaller and the larger units if they compare as 1 : 1000. If the smaller unit is $\frac{1}{10}$-inch in size, a bar graph representing 1000 units would be 8½ feet in length, while a similarly proportioned sphere graph would be only one inch in diameter. As graphs larger than one inch long are rarely permissible on statistical maps, the use of three-dimensional graphs is often imperative.

The most commonly used three-dimensional diagram is the sphere graph. It combines a small, compact size with good visual three-dimensional impression and maps in the sphere system look very vivid. The system, however, has also certain disadvantages. First of all the little spheres are not easily commensurable. A classroom experiment has shown that the larger spheres are usually underestimated. Thus a sphere 100 times larger in volume than another was estimated in average as being not more than 25 times larger. Some of the students' estimates were as low as 5 times. Furthermore, the spheres cannot be subdivided conveniently, which is often required especially in maps of manufacturing. Sphere graphs are also difficult to label since the lettering cannot be placed either inside or outside conveniently.

In view of the many disadvantages of the sphere system another method is here proposed which in lieu of a better term is called the "block-pile" system. (The system described in the following seems to be so obvious that it is not impossible that it has been used already in publications which escaped the author's attention. Somewhat similar blocks are used in the atlas *Gesellschaft und Wirtschaft, Leipzig and Wien, 1930.* Even if the technique is found already in use, its recommendation for geographical papers seems to be timely.) The block-piles require only very slightly larger space than the spheres, but they have the great advantage in that the amount represented by each block can easily be counted. The method of arrangement of the block-piles is apparent from Figure 2.

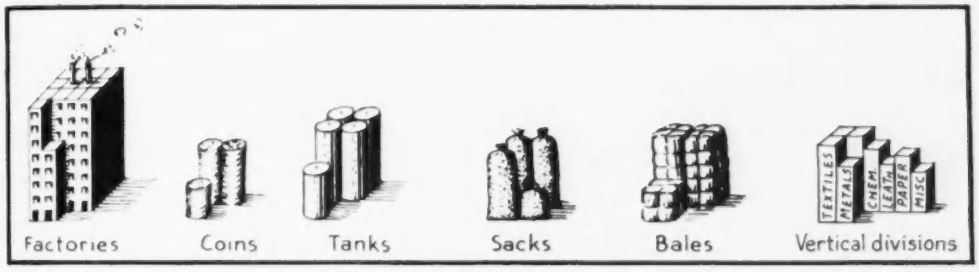

FIGURE 3.—Pictorial block-piles.

The basic unit of the system is a small isometric cube (or better, one half of a cube as shown in Figure 1). These cubes are placed upon each other to form pillars, containing not more than ten or sometimes twenty units. The amount represented by the basic cube has to be decided for each map so that in the place of densest accumulation the block-piles do not crowd each other too much. A practical minimum size for the unit block is $\frac{1}{16}$th of an inch. There is no difficulty in showing half or quarter units by making the height of the block correspondingly less. Larger numbers are expressed by placing the pillars next to each other in a compact

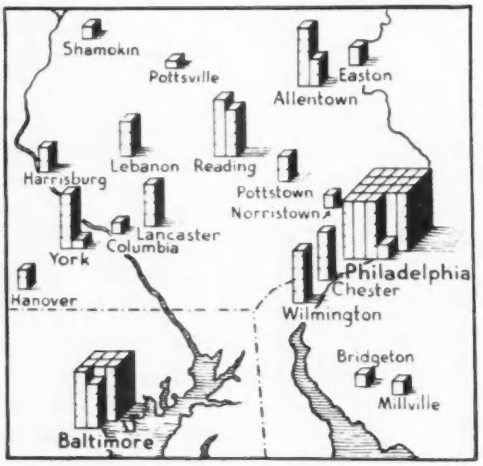

FIGURE 4.—Part of a block-pile map showing the number of wage earners in manufacturing.

arrangement with the fractional pillars in the front as shown in Figure 2. To represent numbers higher than 1000 the use of pillars of 20 units is recommended. In the case of very wide block-piles it is better to draw them with perspective foreshortening, because in perfect isometrical delineation they seem to expand backwards.

The block-piles are blackened on the shadow side and a cast shadow is drawn to increase the vividness of the maps. If placed on the map the block-pile is located so that the center of its base should be over the city it represents. If there is not enough space one block-pile may slightly cover the other and as long as part of the front and the top are visible the pile can still be counted. It is also possible to move the block sideways and point with an arrow issuing from the bottom of the block to the exact location of the city.

Blocks can be subdivided horizontally and marked off by shading or labelling. Subdivisions can be made also vertically as shown in Figure 3. The various types of manufacturing can be represented by this method. Block-piles may be labelled underneath; it is also possible to place the name of the city right over the block.

Block-piles can easily be substituted with pictorial symbols, favored in popular and educational maps. Money value can be expressed by piles of coins in which as many as fifty coins can be placed upon each other. It is good to set off slightly every tenth coin for easier counting. Statistics of manufacturing can be shown by factory building blocks in which the number of stories can be counted. Similarly bales, boxes, and tanks can be used for various other statistics.

Several types of statistical maps can be made by the block-pile system. This method is especially adaptable to maps of manufacturing showing either the number of wage earners or the "value added by manufacturing." Part of such a map is shown in Figure 4. Mining production can also be well expressed by the block-pile method as the different kinds of products are easily differentiated by index letters. The application of the block-pile method to density of population maps has also been attempted and the experiments so far seem to be promising.

THE PULQUE INDUSTRY

Raymond E. Crist

IN many areas man is quite dependent for a livelihood upon one plant—either as a subsistence or as a cash crop. He becomes so dependent as to be practically parasitic, helpless should the plant be taken away. In many tropical areas the banana, or plantain tree acts as a host for man. Deprived of this source of food the primitive peoples of many such regions would perish. Such, in the Valley of Mexico, is the maguey plant, upon which the living of many people depends. To the poor man the leaves serve as a roof. Ropes, string, bags, sandals, and mats are made of the firm fibers of the broad leaves. The heart of the maguey stock is roasted, crushed, and allowed to ferment, and from this pulp the relatively expensive liquor known as mezcal is distilled. But the juice which is extracted from the maguey plant by a very simple operation ferments readily and forms pulque, the common drink of the poor man, sold in great quantities in thousands of pulquerias throughout the country.

The Maguey Plant

The maguey plant is remarkably adaptable; it is found growing on very dry land at low altitudes as well as in rainy lands at elevations of 8,000 feet or even more. In some places it is used as a fence line marker, and in others to prevent erosion in high steep areas. In either case gathering of the agua miel (honey water) is a kind of supplementary occupation, comparable to milking a few cows and selling the cream on farms in the Middle West. The pulque made under these circumstances is usually for home use or to be sold locally. Thus the plant thrives on well drained land which receives plenty of rainfall as well as on soils so shallow, dry, or porous that other crops will not grow on them. Hence it is found covering vast areas of the poorer, semi-arid lands and steeper slopes. The long period required to attain maturity, during which the maguey plant yields no return on capital invested, makes costs of waiting for returns on the investment considerable. Furthermore, as the individual plant yields agua miel—the raw material for pulque—only once for a short period during its lifetime and then dies, a large plantation is needed to support a permanent industry. Hence the large hacienda, with its vast area, ample capital, and extensive methods was ideally suited to maguey production.

Some Effects of the Breaking Up of the Haciendas

Many great estates in the southern part of the Valley formerly maintained extensive maguey plantations, which were often concentrated on poorer slope lands, whereas their irrigated fields on the valley floor were devoted to other uses. In many cases however, the entire hacienda was in maguey, as this one-crop farming reduced operating costs to a minimum. Some of the haciendas had in time encroached upon common lands, or ejidos, which were originally owned and worked collectively by Indian villages. Thus deprived of their support the Indians were forced to seek work on the haciendas where they were at the mercy of the hacendado. With the present trend toward breaking up of these great landed estates, it is precisely in this

densely populated area that demand for village ejidos has been most insistent, with the result that even to the casual traveler it is apparent that few large stands of maguey have been preserved. Most of the former maguey fields are now used for subsistence crops, especially corn and beans. The plants that still survive will be tapped at maturity, of course, but no new ones are being set out in their place (Figure 1). This change in agricultural practice is not always desirable and it would be well if the Agrarian Committees had a trained geographer or agronomist to pass upon the advisability of breaking up certain estates which are located upon land that is largely submarginal for anything but maguey. In many cases the peons who are given the plots continue collecting the agua miel and selling it to the former owner. Once all the plants are used up the new owners move away, possibly to augment the growing urban proletariat, and the land reverts to weeds. Some of the plots may be more favored than others, either in fertility of soil or in proximity to water available for irrigation. The peons on such plots have little difficulty in supporting themselves and their families. But since they do not own the property outright and are probably illiterate and incapable of dealing with lawyers and committee leaders, they may lose it to someone who has pull with the local Agrarista, either through bribery, blood relationship, or political wire pulling.

CHANGING SETTLEMENT PATTERNS

Just outside the city of Mexico for some ten miles along the highway to Pachuca the land tends to be somewhat swampy, and is in pasture. Here many animals are fattened for the city market.

FIGURE 1.—Field in an expropriated Maguey hacienda in which subsistence crops are being grown between the rows. (Courtesy of W. H. Haas.)

Then for a number of miles subsistence crops predominate. The inhabitants live in villages and go out to their fields each day. But gradually one notes that the maguey plantations increase in size until by the time one is fifty miles from Mexico City they have become the most conspicuous feature in the landscape. This is especially true of the sub-humid lands with steep slopes and also on the areas bordering the semi-arid bolson floors. Here population is concentrated on the occasional huge hacienda instead of in villages as farther south. Toward the valley floor one notes that corn is commonly being grown between the maguey plants, which are not being replaced, so that within a few years maguey will be relegated to the steep rocky slopes. The

houses of the great haciendas which have suffered expropriation are in great part deserted. The peons have left to make their homes in huts on the plots allotted them. Thus there is at present in such areas a gradual change from agglomerated to dispersed settlements, which may or may not prove permanent. The peons live in adobe hovels covered with maguey leaves, and crowded with children. Eight to ten births in a family are common, and in spite of an exceedingly high rate of infant mortality families of five living children are by no means rare. The huts seem almost a part of the natural landscape, so well do they blend with their surroundings. In a corral made of brush may be the family burro and goat. The peons engage in growing subsistence crops, mainly corn, and in collecting agua miel to sell to the hacendado to get a little cash.

THE MAGUEY HACIENDA AFTER EXPROPRIATION

A hacienda seldom consists of more than four or five hundred acres; the maguey plants are growing hard by the buildings, and scale the slopes as far up as they can possibly take root and get enough moisture. The plants on an hacienda do not have the dilapidated appearance of those which have been taken over by the peons. In most cases they have been set out in rows, and the fields have the familiar checkerboard lines. In the driest areas a shallow depression may be dug around each plant in which surface water from the scanty convectional showers of summer is retained. Barley or kaffir corn may be planted between the rows to provide fodder for the animals of the hacienda, and to maintain a loose tilth which conserves the moisture in the soil. The field workers set out new maguey plants to replace those that mature and die.

The maguey plant takes from seven to fifteen years to mature, depending on the soil, slope, and amount of rainfall. It is a plant of the cactus family which has thick, heavy, thorny leaves (Figure 2). When the central stock, which would bear the flower if left undisturbed, attains a height of about six feet it is cut off near the base and a small hole is scooped out in the center of the stump. Care is taken not to harm the leaves. All the juice which would go into the flowering of the plant accumulates in this hole and is known as agua miel. The fresh agua miel is a clear liquid, tasting something like coconut milk, only much sweeter. In the beginning only about a liter of liquid is produced each day, but toward the end of the production period as much as eight liters may be taken from the plant daily. The plant should be freshly cut each day and the scar of the cutting the day before removed. As the cutting continues the big leaves gradually wither, and when it reaches the roots the plant dies. The tlachiqueros visit each plant daily during the four to six months that its sap continues flowing into its scooped-out heart. A long pointed gourd with a hole in each end is inserted in the liquid and the man sucks at the hole in the upper end of the gourd till the liquid is drained from the hollow, then he places his finger

FIGURE 2.—A maguey plant just before maturity.

over the lower vent, into which a spout is sometimes fixed, and empties the contents into the skin or keg on the back of the waiting burro (Figure 3).

THE MAKING OF PULQUE

The liquid is conveyed in the small kegs or skins on burro back to the factory (Figure 4), the special building where the pulque is made. Here it is placed in large cowhide vats and the madre (mother) or semilla (seed) pulque, is added. This seed pulque is made in the following way: a liter or two of the fresh agua miel is poured each day into a 500 liter vat, increasing the amount slightly each day, until the vat is filled. Then three-fourths of it are poured off, and agua miel is added to the one-quarter left till the vat is full again. Then one-half is poured off and the vat gradually filled again. The remaining liquid is seed pulque. The amounts added daily seem to vary in different pulque factories, but the amount of time

FIGURE 3.—Collecting the agua miel.

required to get the seed is usually about three months. But seed is seldom made; when the encargado (man in charge) of the pulque factory runs out he simply borrows it from a neighboring hacienda. When seed is added instead of made the procedure is as follows: to each 50 liters of agua miel six liters of seed are added. This is then divided into two lots of 250 liters each and put into 500 liter vats. Then 50 to 100 liters are added to each vat daily until the drink is ready to market—in from two to six days. But not all of it is marketed at once: a portion of the liquid is removed and sold each day, being replaced by fresh agua miel. Continued fermentation in the daily diluted mass produces a steady supply of pulque for from two weeks to a month, at the end of which time the vat is emptied, cleaned, and dried in the sun. Pulque is a foaming whitish liquid with a very sour smell. Fermentation is caused by the same bacteria that are found in yeast. I visited the hacienda of Mr. Rule near Pachuca, and Mrs. Rule told me that she always used pulque instead of yeast in making her bread—1½ liters of pulque being required for a batch of 3 or 4 large loaves.

MARKETING THE PRODUCT

When the pulque is ready it must be quickly conveyed to the consumer, since, like milk, it is perishable. Hence areas of production have become localized within such a radius of Mexico City, Puebla, and Pachuca and other urban markets that rapid daily shipments can be made. Just as we speak of the milkshed of large urban agglomerations in the United States, so one could speak of the pulqueshed of large towns in Mexico. With the constructing of hard-surfaced roads the motor truck is rapidly taking from the railroads the business of transporting pulque to the markets. Off the main highways, however, the pulque is still transported in 250 liter barrels from the hacienda to the railroad by wagons; in the rainy months, however, the beverage may be carried on mule-back in small kegs or skins (Figure 5). Not only is the area of pulque production localized with reference to the time it takes to get the finished product to market but also with reference to prices

and to the freight-rate structure. When prices were high Mr. Rule used to send pulque as far as Tampico at a profit. Now the price is such that his crop can not pay the cost of transportation much beyond Pachuca. However, the amount of capital at hand and proximity to a good highway are important. For instance, a large hacienda located on a good road with large trucks of its own can thrive a hundred miles or more from its market, while the products of a small hacienda far from a good highway must be consumed locally.

COMPOSITION OF PULQUE—POSSIBLE BENEFITS OF ITS USE

There is a law in Mexico which prohibits the sale of pulque after 24 hours, as continued fermentation soon renders it unfit to drink. Certain dealers, however, mix with the pulque the juicy pulp of the maguey plant, sodium bicarbonate, and cube sugar to make the drink potable for 48 hours. The pulp serves to restore the body which is lost after the first 25 hours, the bicarbonate of soda produces effervescence, and the cube sugar induces further fermentation. There appears to be no fixed formula for this mixture, just as there is no exact formula for the drink itself. Pulque is reported to contain from 8 to 20 per cent of alcohol and to have the same habit-forming effect as other liquors. It is commonly believed to be beneficial to persons suffering from kidney trouble and diabetes, but there is as yet no proof of this. It is indulged in frequently and freely by Mexican laborers—particularly mine workers—and agricultural workers, but both its taste and odor are usually repugnant to the uninitiated. Since the main diet of the Mexican worker consists of corn and beans, pulque would seem to have the advantage of being somewhat of a laxative, thus making up for the absence in the diet of roughage in the form of fresh fruits and vegetables. There are two important factors which have contributed to heavy consumption of pulque by Mexican peons: (1) dearth of pure drinking water; (2) monotony of a life of unrelieved toil.

FIGURE 4.—Taking the agua miel to the pulque factory.

CONCLUSION

In conclusion it might be stated that the maguey hacienda has retreated—and is still retreating—to dryer portions of the valley. Its extensive methods, use of poor land, and concentration on a crop so well adapted to its harsh environment, give it a great advantage in coping with the adverse physical conditions in a region where the rural population is scanty. Consumption of pulque, may, of course, decrease and indeed government campaigns designed to bring about a reduction in consumption are carried on. (Paradoxically enough, certain villages are being encouraged by the government to continue production of pulque. Octlán has prospered largely because of a thriving pulque business, which brings in cash when other crops fail.) There is no doubt that the drinking of pulque to excess is harmful to one's health. But it would be as hard to eradicate the habit of pulque drinking in Mexico, established as it is by centuries of popular usage, as it would be to have the German stop drinking his beer,

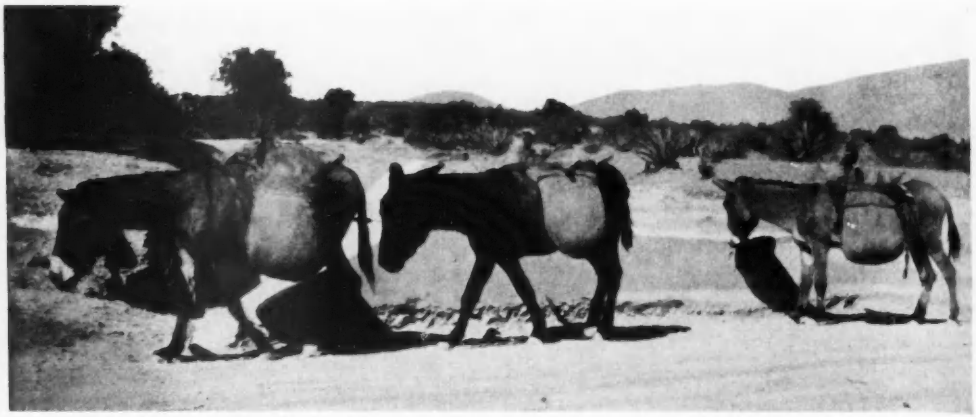

FIGURE 5.—Transporting the pulque to market in pigskin bags. (Courtesy of W. H. Haas.)

the man of Brittany his cider, or the Italian his wine. Hence for physical, economic, and social reasons it would seem that the maguey hacienda is assured of a certain degree of permanency as a rural institution in the drier, steeper, and more rocky areas of the Valley of Mexico.

Note: The author expresses his gratitude to Mr. Henry S. Sterling, who is completing work for his Doctorate at the University of Wisconsin, and to James B. Stewart, American Consul General in Mexico City, for their ready coöperation in helping him assemble the data used in this article.

CACAO INDUSTRY OF BRAZIL

Elizabeth Keithan

BRAZIL exceeds all other Latin American countries by far in the exportation of cacao. The exportation of 134,172 tons in 1936 was the largest to date, in the history of the country and was exceeded in world export only by the Gold Coast of Africa which exported in the same year 338,386 tons. (Since relatively small amounts of cacao are consumed in Brazil and the Gold Coast, export figures and production figures are practically the same.)

Cacao grows wild in several regions of Brazil where natural conditions are favorable. Its commercial production is generally confined to the states of Amazonas of the Upper Amazon Basin, in Para' and Piaui' of the Lower Amazon Basin and to several selected areas on the coastal lowlands of eastern Bahia.

Lower Amazon Region

In the early part of the nineteenth century many cacao plantations were established on the banks of the Amazon river and its main tributaries. From 1852 to 1862 the average annual export was 3,076 tons. For a time increase was slow, then rapid to 1888, the banner year, when 9,000 tons were exported. With increasing yields and favorable prices, the plantation owners expected to continue to dominate the market without much effort on their part. Production remained steady with slight variations from 1888 to 1915 but 1915 to 1918 the average annual export fell to only 3,704 tons, not much more than it had been sixty years before. Since then the exports have continued to decrease until they have well-nigh become negligible.

The present outlook for the industry within this region is not bright. Most of the plantations are from seventy to eighty-five years old and few new plantings are being made. The decline of the Lower Amazon industry has resulted partly from (1) ravages of insect pests, (2) frequent floods over relatively low-

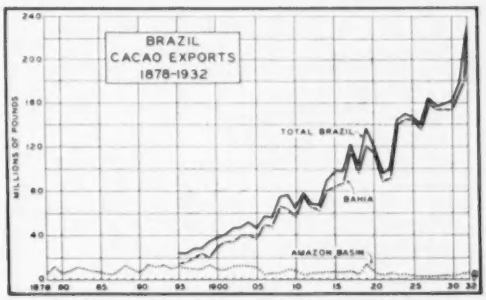

FIGURE 1.—Cacao exports, Brazil, 1878–1932. (Source: Clarence F. Jones, *Commerce of South America*, 1928, and writer.)

lying plantations, (3) lack of pruning, (4) thick stands of trees, and (5) neglect to provide shade and wind-breaks. Some of the causes are attributed to the lack of an adequate labor supply and careless production practices. An additional reason for the decline of the cacao industry in the Amazon Basin has been the competition afforded by the same industry in the state of Bahia. By 1895 the exports of cacao from that state surpassed those from the Amazon Basin and since that time the production of Bahian cacao has increased to relatively large proportions (Figure 1).

Region of Eastern Bahia

The Bahia cacao region is located in the eastern and southeastern parts of the coastal lowland of Bahia in eastern Brazil in separate and distinct areas not

far from the sea, it extends approximately from Rio Jequirica to the boundary of Espirito Santo, the state south of Bahia, and is about 360 miles long and from 10 to 100 miles wide (Figure 2). In the region are planted about 110,000,000 trees on 500,000 acres of land, averaging 220 trees to the acre. The plantations are not regularly distributed, but are grouped about centers, sometimes separated by long stretches of virgin forest, while others continue without interruption over large districts. The producing centers may be divided into three groups; the first from the river Jequirica to the river Una, includes the important centers of Jequi, Rio Contas, and Ilheos, the largest of the districts; the second is situated on the banks of the rivers Jequitinhonha and Pardo; the third is formed of more or less isolated plantations southward. A river and its tributaries always form the center of distribution of the plantations.

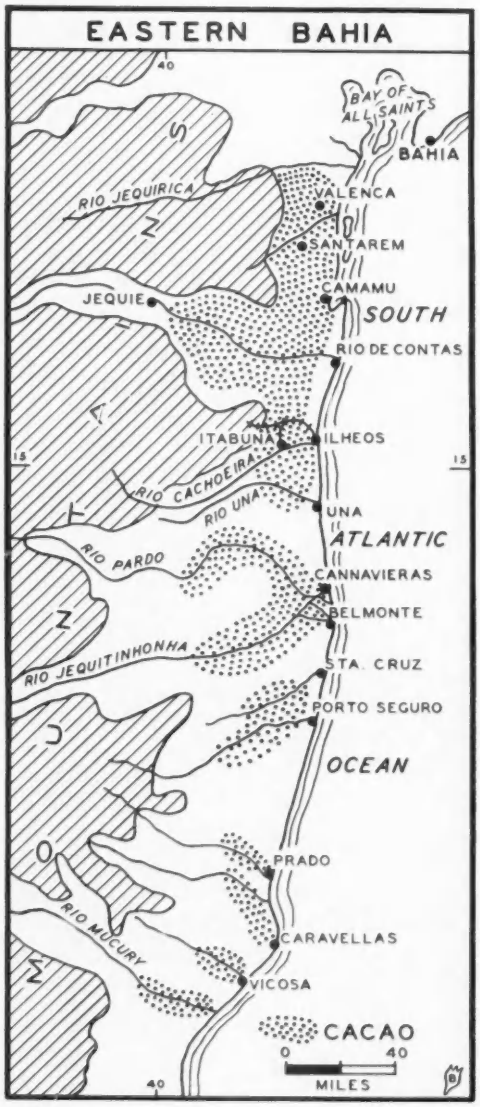

FIGURE 2.—Cacao and physical map of eastern Bahia, Brazil. After Wanderley de Aranjo Pinho. (Source: Vidal de la Blache et L. Galois, *Geographie Universelle*, Tom XV, 1re Parte, *Amerique Du Sud*, par P. Denis Paris: Librairie Armand Colin, 1927. An adaptation.)

In the first group the plantations are found on the banks of the rivers and numerous other streams, on the hills, on their slopes, in the intermediate valleys—in short wherever the cacao tree thrives. In the second group, the plantations lie on banks of the rivers on rich alluvial plains, often inundated by high floods, for which reason new plantations are being laid out on higher ground. The third group, the newest of them all, shares in some degree the features of the first two. The difference between the first two groups is shown in the quality of the product. The cacao coming from Belmonte and Cannavieiras, of the second group, is better prepared and of better quality. In the Jequitinhonha center are found the best equipped and best cultivated plantations. The first group, although it produces good cacao and has good plantations, is divided into smaller farms under numerous proprietors who cannot, because of shortage of labor, give the product the care it requires. This group, in which are Ilheos, Rio de Contas, Jequi, Santarem, Camamu, and Una, supplies almost 76 per cent of the total output of the state (see Figure 2).

The cacao region of Bahia extending from about 13 degrees to 18 degrees south latitude, is characterized by regular rains, even temperatures, humid atmosphere, presence of tropical forest and soils rich in humus or fertilizing matter. Over so large an area, the conditions certainly vary somewhat, but on the whole they are not noticeably different. Plantations occupy low hills not over 1,000 feet in altitude in the north, and levees of rivers at a much lower elevation in the south. The cacao tree produces at greater altitudes in this region, but the transport of the crop is more difficult and since there is plenty of land available at lower levels, upper slopes will likely be utilized for further extensions of the plantations.

The region is characterized by rainy, low-latitude types of climate. Full climatological data are almost lacking except for two stations, Ilheos, located almost within the heart of the region, and Salvador (Bahia), the capital city, 120 miles to the north. The average annual temperature for Ilheos from 1909 to 1919 was 76.4 degrees F. and the average rainfall for 1912 to 1919 was 88.8 inches. Relative humidity for one year was 87.9 per cent. The prevailing winds are east. The average temperature of Salvador (Bahia), was 77 degrees F. with an annual rainfall of 80 inches, with a high relative humidity and prevailing easterly winds.

For the region in general the average temperature is estimated to be from 77 degrees F. to 81 degrees F., the maximum 91 degrees F. and the minimum 56 degrees F. Temperature of 91 degrees F. is recorded on a sunny day, followed by a drop to 65 degrees F. the next morning.

The annual rainfall averages from 70 to 80 inches and more, and there is rain every month. Some months are considerably rainier than others and it is in these rainier months that the cacao grows rapidly, provided there is sufficient sunshine. At Ilheos it may be said that the rainiest months are from January to May and the cloudiest and coolest months are June to September (see Figures 4 and 5).

The relative humidity of the atmosphere is usually high. During the night and early hours of the day, fog may cover the valleys, the savannahs, and even the hills.

The east coast of Bahia has easterly winds in all seasons, southeast in July and east and northeast in January, when there is a monsoonal inflow to the heated interior. Since most of the showers are of the convectional type, the winds have little to do with their occurrence, but they affect the temperatures, especially near the coast, making the region somewhat more pleasant for residence. Uniform tem-

FIGURE 3.—A cacao plantation in the valley of the Jequitinhona River, Bahia, Brazil. Variety "Common." (Source: Dr. Gregorio Bondar, *El Cultivo del Cacao*, Pan American Union, Washington, D. C., 1938.)

peratures accompanied by heavy rainfall, together with periods of bright sunshine and gentle winds, combine to make the region one of the best cacao regions of Latin America—and of the world.

The soils where the cacao is planted are usually good, rich in plant nutriment. The area was formerly covered by dense tropical forest. Analyses have not been made and so the composition of the soil is not known. On the banks of the rivers, in the plains, and in the deep valleys between the hills, soils are high in humus formed from deep beds of decomposing vegetable matter. Most of the plantations are laid out upon the commoner sandy loams and clay soils. On the slopes of the hills, fertile clay soils excellent for cacao, are formed from the decomposed native rock. Numerous plantations on such soils distinguish the vicinity of Ilheos. At Belmonte and Cannavieiras the predominating soil is alluvial, rich in humus, on the banks of rivers. In the other producing centers good alluvial soils are found but residual soils are most widespread.

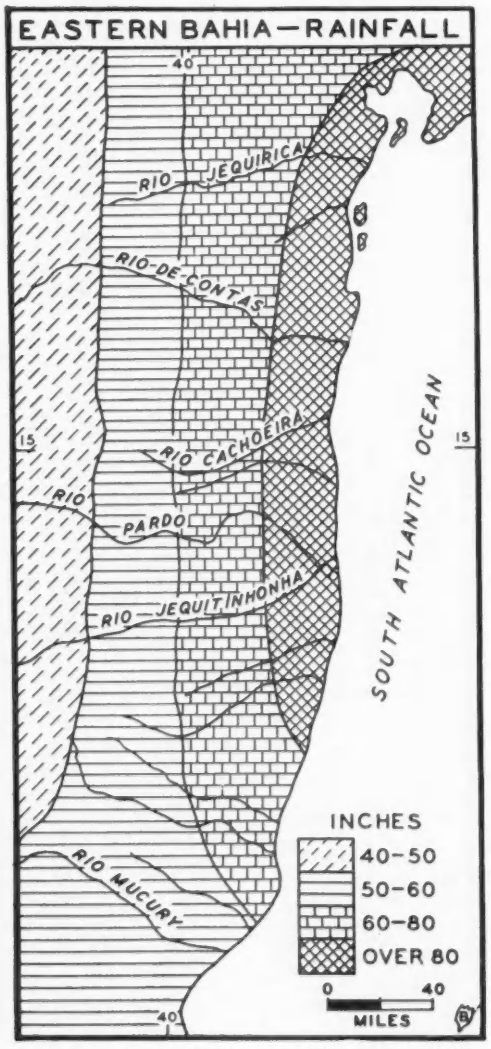

FIGURE 4.—Rainfall map of eastern Bahia. (Source: Clarence F. Jones, *South America*, New York: Henry Holt & Co., 1930. An adaptation.)

With the exception of Cannavieiras and Belmonte, where soils are better chosen and prove more fertile, planting is done without much regard to the conditions of the soil. On sandy soil, in places where compact rock is present, or where water accumulates and forms permanent marshes no planting is done. With this careful procedure good crops have been obtained so far. The average production is much lowered when poor soils are chosen for planting. There is no need for such choice for there is still much fertile land unused.

About nine-tenths of Bahia cacao plantations are found on the higher or sloping land and about one-tenth on the low plains bordering the Pardo, Jequitinhonha and Murcury rivers. The distribution coincides with the stream pattern and insures to most of the plantations adequate drainage. Added to this natural drainage the permeable soils with a minimum of silica and sufficient amount of clay to hold water in time of rains for periods when little rain falls increase the advantages for cacao production.

The cacao industry is the largest and most important industry in Bahia, for

although there are no official statistics, it is estimated that over 750,000 people derive their income from it, folk directly or indirectly connected with the industry, engaged either in its commercial aspects or else interested in its agricultural phases. The population density in this region is estimated to be from thirty to sixty people per square mile, composed of Indians, Europeans, and negroes.

The region has shown for many years a distinct adaptability for the production of cacao, yet the industry dates only from the later years of the nineteenth century. Prior to the 1880's, most of the present cacao area remained virgin wilderness. When the emancipated slaves from the northeast sugar districts of Brazil migrated, in 1888, to the region, they formed an increased and steady supply of local labor for carrying on the industry. The natives and their descendants are now living mostly on the plantations, large and small, in their own huts or in others provided for them by the owners.

There are no available statistics as to the proportion of population engaged in any particular phase of the industry. There is reason to believe, however, that the number employed is fairly constant and sufficient, except at harvest time, when additional labor and supervision to harvest and market the product are provided by crowds of traveling laborers from the north who work their way south to the coffee plantations in Sao Paulo. Some are secured also from neighboring villages and towns.

Some planters live on the cacao plantations for all or part of the year, but the greater number of owners live in the larger towns, in Bahia or abroad. The cacao merchants who are interested in the exporting phases reside largely in the cacao centers in or near the coast.

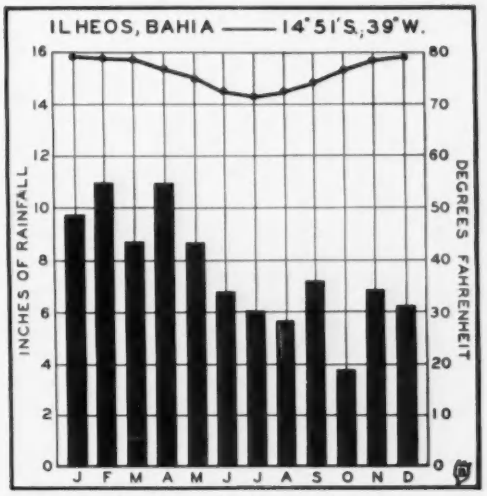

FIGURE 5.—Record of rainfall and temperature at Ilheos, Bahia, Brazil. (Source: Koeppen and Geiger, Handbuch der Klimatologie, Band II, Teil G. Kr. K. Knock *Klima von Süd amerika*, Berlin, 1930.)

They make up a large part of the population engaged in the industry.

The transportation pattern of the cacao industry is, for the most part, coincident with the stream pattern of the areas in which cacao is produced. Most of the cacao is raised within 75 to 100 miles of the coast and usually in close proximity to river transportation. Except for a few miles of rail and motor roads serving the districts of Ilheos and Carvallas, water provides transport for almost all the cacao that reaches the coast (see Figure 2).

A large part of the product is carried by native laborers and by pack-mules (Figure 9), from the plantations to the nearest river, at considerable expense and here it is transferred to canoes for transport to the nearest ports along the coast. The small cacao-port centers are served by Bahian coast-wise ships (Figure 10), schooners and launches which transport the cacao either to Ilheos or Salvador (Bahia), the leading cacao seaports of the state.

HISTORY AND TRENDS OF THE INDUSTRY

Cultivation of cacao in Bahia is said to have begun in 1746, from seed brought from Para' by the French planter Louis Frederic Warneaux. The seed was sown on the right banks of the river Pardo in the county of Cannavieiras by Antonio Dias Ribero. The Portuguese government took an interest in the cultivation and tried to assist in production through its agents, who were designated "Conservers of the Forest."

The tree soon became well known and is occasionally referred to in the records and writings of the period. But that cacao had all but faded from the thoughts and occupations of the Bahians is indicated in the works of the great German botanist, Martins, who when visiting southern Bahia in 1819 wrote as follows: "This culture had a very happy beginning, but actually there remains scarcely a vestige of it in the maritime villages, and it was only at Camamu that a few trees were encountered, and their luxuriant aspect demonstrates beyond a doubt their ready adaptation to the region."

About 1818 Pierre Weyll and his companion, Sanaraker, obtaining a grant of land in eastern Bahia from the king, on two occasions brought German planters to colonize this land. At that time people were interested in the cultivation of sugar cane, coffee, and tobacco but the cacao tree was also planted. Old cacao trees of these first plantations by the German formed the nucleus of the industry at Ilheos. In 1778 the export of cacao from Bahia

FIGURE 6.—Cacao soil, Bahia, Brazil. The white line marks the division between the top soil and the slightly decomposed crystalline rock. (Courtesy of Dr. Gregorio Bondar.)

was about 2,000 pounds; cultivation developed slowly and in 1835 the export reached about 59,000 pounds.

The second German colony was established on the Rio Cannavieiras, and by 1852 the plantations had attained prosperous aspect. The culture spread to Belmonte, Rio Contas, and Valenca, in fact to the whole southern Littoral. In 1868 exportations had amounted to 815 tons, largely as a consequence of the influx of emancipated slaves from the sugar districts to the north, of the adaptability of the region to cacao, as previously mentioned, and of high prices paid for it at the time. Statistics show the amount of exports of cacao from Bahia to have increased yearly (see Figure 1), from an insignificant place to a position of prime importance in the industry of the state. The attainment of this position is attributed not only to the adaptability of the tree to the region but also to the phenomenal increase in the consumption of cacao throughout the world during the first quarter of the present century.

Though there appears no reason to suppose that cacao production in Bahia will not continue to increase, the industry labors under a number of handicaps, such as high export and municipal taxes, heavy transportation charges, and sometimes scarcity and costliness of labor. Because there are not enough permanent workers on the plantations to harvest the crop, as before stated, planters must rely on casual labor at harvest time. Such labor is generally of mixed Indian and Negro type and is not highly competent. It must be paid in cash which is generally secured on credit against contracts to deliver cacao, a system which naturally tends to depress the price the grower receives for his product.

Planters have agitated considerably for some sort of government protection against fluctuations in prices, such as already exists in the coffee trade, but they generally recognize that the obstacles in the way of such a scheme are difficult to surmount chief among them being the fact that cacao cannot be stored for any length of time in a hot, damp climate. Moreover, Brazil does not occupy the same commanding position among the world's cacao growing countries as among the coffee producing countries.

FIGURE 7.—A plantation of Pará cacao located in the valley of the Mucury River, Bahia, Brazil. (Courtesy of Dr. Gregorio Bondar.)

It is claimed that Bahia is ideally situated for the production of cacao and land recently opened up is said to be better suited for cacao production than any to be found in the state. In spite, therefore, of factors militating against the development of the industry, it seems likely that production will continue to increase.

MARKETING OF THE CACAO

The greater portion of the cacao grown in Bahia is exported. What proportion of the crop is marketed abroad is not known but since production figures and export figures are used interchangeably, it is reasonable to believe that it is almost 100 per cent. Home consumption is very small for the natives prefer other beverages to cocoa, and chocolate in the form of candy rarely enters their diet.

In addition to this, cacao constitutes a large share of the total amount of the agricultural exports of this region. Statistics show that this product constitutes over 80 per cent of the total value of exports. The importance of cacao is relatively greater than the export figures indicate, because of the number of people who are dependent on one phase or another of the industry.

The dependence on cacao is emphasized by the fact that the majority of the cacao planters are natives who reside in the region, spend their incomes there, and for the most part employ native labor. If the crop to which they look for their cash income is good and the price of cacao is high, those interested in the industry directly or indirectly prosper; but if the crop is poor or the price is low, business is depressed and those interested in the industry suffer. In addition, marketing methods have much to do with the success of the industry in each region. Careful and clean methods of disposition of the crop have a distinct effect upon the material well-being of those connected with it. If the methods are careless and unsanitary, results in decreased exports quickly become apparent and business is affected accordingly.

FIGURE 8.—View of the experimental station of the Cacao Institute of Bahia located on the Agua Preta. Note the distribution of the main buildings and the houses of the workers. (Source: Dr. Gregorio Bondar, *El Cultivo del Cacao*. Pan American Union, Washington, D. C., 1938.)

FINANCING THE CROP

The objectives of the association organized for the purpose of advancing money to cacao planters in Bahia in-

clude aid in planting, cultivating, grading, and marketing the crop. Here the Cocoa Institute of Bahia was established June 8, 1931, to regulate and improve production, grading, and marketing of cacao beans. Up to the present, chief activities of the Institute have been to finance production and marketing. So far, nothing but propaganda and advice have been given to improve methods of production and grading has been left to the local exporters. The Institute appoints inspectors to supervise grading and gives certificates to interested persons. It has been advancing money to planters, up to 70 per cent of the market value of the cacao beans consigned to it. The money is derived from a $1,050,000 issue of bonds for this purpose. The Institute exports the cacao beans thus consigned to it and purchases for other local dealers.

SELLING PRICE AND DEMAND

Until recently Bahia received fair to good prices for cacao. As early as

FIGURE 9.—Pack mules carrying cacao, Bahia, Brazil. Pack mules afford the most efficient mode of transportation where there are no roads and where the constant rains make it difficult to maintain roads. The average pack mule carries 150 pounds and earns about 40 cents a day for his driver. (Source: Companhia Energia Electrica Da Bahia, *Information Sheet*, No. 3.)

FIGURE 10.—Bahian launch. This particular vessel, the "Bahia," travels between the Port of Camamu and Bahia (Salvador), making one round trip a week. (Source: Companhia Energia Electrica Da Bahia, *Information Sheet*, No. 3.)

1928, however, prices began to show a downward trend. A decreased market on the part of American buyers, an abortive attempt at cacao valorization, increased export taxes both state and municipal, and considerable losses by a number of export houses in Bahia which indulged in speculative transactions in cacao have led to the decline.

Continuing increased production of ordinary cacao in the regions of West Africa stimulated by increased consumption of such low-grade product in the United States and Europe aggravated the situation. In order to sell their crop the Bahians were forced to reduce their selling price to such low figure that it barely covered production costs. Had it not been for increased world consumption and the extreme depreciation of the milreis (Brazil's unit of money = 10 cents in United States money) whereby farmers received more milreis for the dollar, the industry would have suffered collapse. The situation shows little tendency to improve unless new factors are introduced to establish a more solid financial basis for the crop.

As has been mentioned before natural conditions for the production of cacao in Bahia are almost ideal. The financial success of the crop, however, depends mainly on the transport, the cost of which must correspond with the market price of the product. If railways cannot be constructed, roads for transport

animals would be sufficient, provided they are well maintained. Localization of adequate labor is a second requirement to supplant merely casual labor, which by its lack frequently causes wage increase. Finally, government measures to encourage and protect planting by laws giving prizes for good produce, prescribing the construction of roads, decreasing export duty on cacao, facilitating the acquisition of land, founding experimental stations, and instruction by agricultural officers about the producing centers in good methods of intensifying rather than extending cultivation; in short to transform cultivation from the present primitive state to modern scientific method. Once these measures are taken, progress may be expected in the industry. They are necessary if the industry is to withstand a continued low price, a price not likely to be improved in view of increase in the world's production of ordinary cacao.

Note: Most of the statistics used in this article were obtained from *The Gordian*, Vol. XLIII, No. 1031, April 9, 1938, published by Max Rieck, Hamburg, Germany.

UNITED STATES SOYBEAN INDUSTRY

George H. Primmer

SOYBEANS, though grown in United States for more than a century, and commercially produced in New Brunswick, New Jersey, as early as 1880, only in the decade 1930–1940 assumed their place as a major crop; estimates for 1938 production approach 50,000,000 bushels.

Recent Phenomenal Acreage Increase

In twenty years past national production multiplied ten times (Figure 1). In the period 1929–1934 Wisconsin production increased more than fourteen and Minnesota acreage more than twenty-one times. In the same five-year period states of heavier production, Ohio, Iowa, Missouri, Indiana, and Illinois, with 2, 4.5, 5.9, 6.2, and 9.5 per cent, respectively, of their "crop land harvested" in soybeans, increased their acreages, approximately, by two, five, two, two, and four times, respectively (Figure 2). In the Corn Belt soybean largely replaced oats with which farmers have experienced economic difficulties since tractors supplanted horses on farms.

Texas reported recently an acreage in four counties equal to that of the entire state for the preceding season. For two years past a futures market formed a division of Chicago Board of Trade operations. A soybean special train displaying numerous exhibits and representing two national associations, of producers and of processors, also served to increase popularity of the crop; besides, soybeans spread to some of the acreage released from other crops under AAA agreements. For benefit of South Africa, a Natal observer recently studied United States soybean cultivation and industrial use.

Soil Relationships

Soybeans succeed in nearly all soil types but yield best on the most fertile mellow loams, especially on those of limestone parent material. Corn Belt

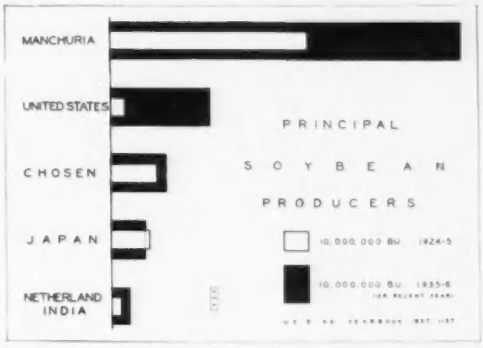

FIGURE 1.—Though absolute increase shows much greater for Manchuria, United States rate of increase stands unique among those of major soybean producers.

states show heaviest concentrations in areas generally considered best for corn, though beans give way in places to special crops as tobacco or sugar beets; some districts rate eight, sixteen, even thirty-two times the soybean intensity of poorer soil areas. Rich land beans may lodge, necessitating extra long pick-up "fingers" on harvesters, whereas poor soil short beans may require mowing. Especially on high-priced rich land soybeans tend to replace oats in the cropping system.

Acid tolerance recommends beans for northeastern Missouri and for light-colored soils of unglaciated southern Illinois. Cowpeas, even more acid-

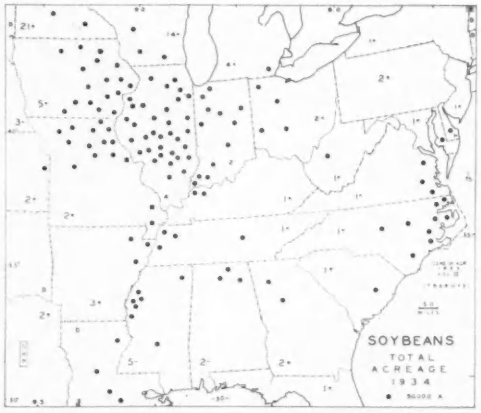

FIGURE 2.—The carefully located 50,000-acre dots suggest areas of heaviest production. The figures show for most states the ratio of 1934 to 1939 acreage (Mississippi 5, and Minnesota 21). The "D" (as in Oklahoma) indicates a 1929–1934 acreage decrease.

resistant, yield more heavily but cure with greater difficulty and loss. Limestone applications and bacterial inoculation bring relatively greater response on thinner sour soils. On rich soils inoculation may not greatly increase yields but it does increase protein content of the plant.

Where, and when, heavier soils crust badly, a rotary hoe, spike-tooth harrow, or weeder breaks the surface so germinating beans may break through. Yields of Anoka sand fields in Minnesota measure but about half those of hay and beans for the state as a whole; soybeans, however, may show more profit on sand than cereals, possibly otherwise cropped.

Soybeans should supplement, not replace, other legumes in rotations. Removal of hay takes away about nine-tenths the nitrogen in the plant. Since beans well supplied with symbiotic bacteria secure but about two-thirds their nitrogen from the air, combines, removing only the seed from fields, constitute the most satisfactory harvesting device (Figure 3). Residues plowed into the soil may contain considerably more nitrogen than the growing crop removed. Soybean growing results in lesser net removal of fertility than that of corn.

EFFECT OF SLOPE

Advocates of wide soybean extension do not recommend them for fields of steep enough slope to make soil wash a serious menace. Though the necessary frequent cultivation of soybean fields improves soil tilth, it expedites erosion from rolling lands.

Greatest yields, and best quality—large, plump, fine quality beans—result from plantings in rows approximating two feet apart. Rows should follow contours rather than stand parallel or nearly parallel to slope; soil loss damage

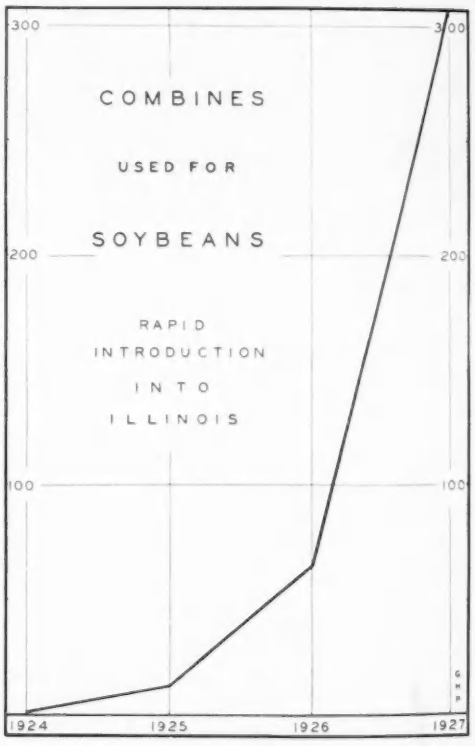

FIGURE 3.—Rapid introduction of combines, on nearly level land the best harvester of beans grown for "grain"; leaving so much residue its use results in near maximum increment of nitrogen to soil. By 1935, estimates indicate about 3,000 combines in Illinois.

remains minimum if the seeder, seeding solid, travels at right angles to the slope.

To decrease erosion and leaching losses some farmers seed a winter cereal after soybean harvest. Spring plowing of rolling land constitutes proper practice, though perhaps less organic matter gets turned into the soil than under fall plowing.

Hilly unglaciated lands of southeastern Minnesota, northeastern and

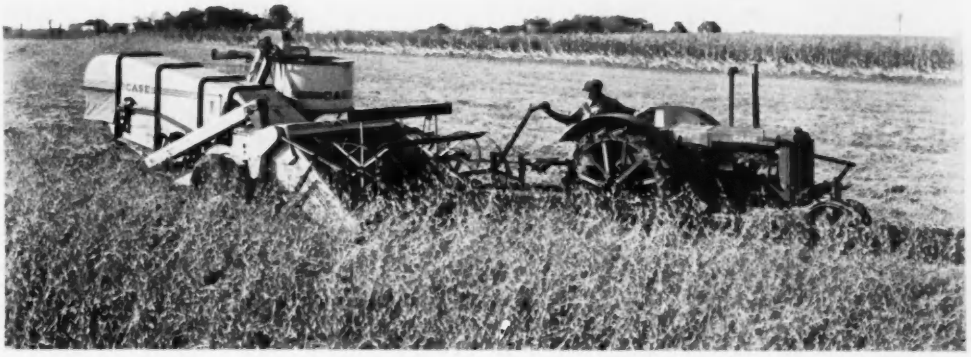

FIGURE 4.—Combine harvesting soybeans from nearly level field where it shows high efficiency. Advance shedding of leaves facilitates threshing; straw drops from the combine and, like the foliage, later decays in the soil.

southern Illinois, southern and northwest Missouri, and southeastern Ohio show much smaller percentages of crop land in soybeans than do bordering areas of gentler slope. Soybeans for "grain" typically concentrate on lands nearly level enough for harvesting with combines.

CLIMATIC INFLUENCES

Of some two thousand five hundred known varieties and strains of soybeans United States growers tried some eight hundred. Those commercially produced fit well into climatic conditions of the Corn Belt and part of the Cotton Belt. Time required to mature varies from less than three to more than six months; thus the new crop readily follows clover or fall-sown wheat killed in severely cold winters. Beans planted ten weeks late, in long growing season areas, mature almost as soon as early plantings, but at sacrifice of quantity and quality of forage and beans. Plants from Michigan-grown seed mature several days earlier than those from southern Illinois beans. Though young plants withstand light frost, extremely early plantings result in reduced yield and require an undue amount of labor.

Since strong direct sunlight proves fatal to soybean bacteria, inoculation on rainy or cloudy days or in late afternoon succeeds best. A period of strong sunlight with high temperature should precede use of a weeder or similar implement; otherwise many of the plants, turgid from absorption of water, snap off. After they wilt somewhat from water loss, cultivation destroys few plants. Tillage should keep weeds subdued until soybeans shade ground (Figure 5).

In higher, as in lower latitudes, United States soybeans chiefly furnish hay. Some Wisconsin farmers grow

the hay after early canning peas. Iron River, Wisconsin, produced hay from a late June planting after heat and drought destroyed clover. Some Ohio Valley beans produce seed sold to areas farther south to plant for quick maturing hay.

Prolonged drought in the critical germination period may prove harmful as excess moisture. Once established, soybeans withstand short droughts much better than corn. Western Missouri, Iowa, and Minnesota show increasing, but relatively low, soybean intensity. Lower yields in drought years materially raise prices, but unfavorable weather seems unlikely to cause nearly total failure as of the tung crop of 1933.

Soybeans, well started, show less adverse effect of excess moisture than do corn or cowpeas. Rains, ruinous to cowpea hay, little more than discolor soybean fodder. In large bundles, however, soybean hay cut by a binder may mold before curing.

Farmers wait for dew to evaporate before mowing soybean hay. On sunny days leaves of hay in windrows wilt but do not necessarily become brittle. Overdry hay, left overnight in windrows, may toughen from absorbed moisture to handle with little loss of the more edible portions. In wet weather haymakers move cocks to dry ground to prevent their bottoms molding. In Cotton Belt rainier areas curing frames, or similar devices to aerate their interiors, form foundations for cocks.

FIGURE 5.—Superior field of Indiana soybeans probably cultivated for last time as plants shade most of the field surface. Two-row corn cultivators or "beet cultivators" may till four such soybean rows simultaneously. A rotary hoe commonly breaks soil crust around beans not in rows, but only while they are still small.

RELATION TO PESTS AND DISEASES

In Asia several destructive diseases take toll of soybeans. Little disease seems to have come in with the plant and no disease yet ranks as of great economic importance in United States. With increasingly expanded acreage, however, spread of disease grows more likely.

Where soybeans grow with corn, chinch bugs cause less devastation than in neighboring fields, possibly because of greater shade and moisture. Though resistant to Mexican bean beetle as well as to the chinch bug, soybeans possess no immunity from insect inroads. Eight known insects attack the plant; their numbers bid fair to increase rather than decrease. Numerous diseases—blight, pustule, wilt, rot, mildew, knot, etc.—though known in United States, as yet cause little damage. Some varieties remain untouched by rabbits when others, which the rodents find exceedingly tasty, show considerable damage. Small fields of soybeans in higher middle latitudes suffer some loss through woodchucks.

UNITED STATES FOREIGN TRADE

Numerous United States counties now annually produce more than the highest, 1929, annual import of soybeans, some 70,000 bushels. Exports have exceeded 100,000 tons; this meant, however, but around 5 per cent Manchurian exports of the same time. Some European mills prefer United States beans above Manchurian.

The 1930 tariff reversed the upward trend of oil meal and cake imports. Within two years this reduction represented the residue from approximately 2,500,000 bushels of beans. Oil imports normally stand high above those of beans or of other bean products. Greatly stimulated when the World War closed to us some sources of other vegetable oils, soy oil imports rose in 1918 nearly to 337,000,000 pounds. A marked drop (Figure 6) followed the 1921 emergency tariff, followed in turn by increased duties in 1930. Recent reports show import duties of two cents per pound on beans, of three and one-half cents per pound on oil, and of three-tenths cent per pound on soybean cake or meal.

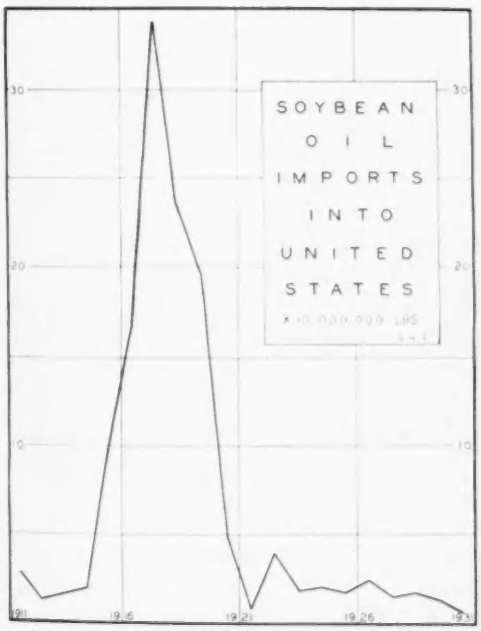

FIGURE 6.—To illustrate response to cutting off some other vegetable oil sources by the World War, the post-war depression decline, and failure to rise again as United States expressed more oil from its increasing home-grown soybean stock.

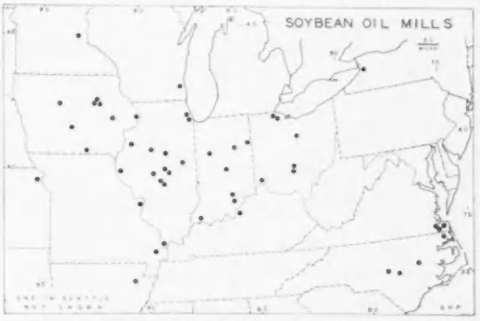

FIGURE 7.—In general, mills stand within or near major cities in areas of fairly high intensity of soybeans grown for seed. Equal sized dots do not indicate equal capacities. A 1910 Pacific Coast mill, not mapped, expressed oil from beans imported from Manchuria. (Locations list furnished by Urbana laboratory.)

USE OF SOYBEANS FOR FOOD AND FEED

Soybeans provided some of the none-too-kindly remembered "coffee" rationed to Union Civil War soldiers. Paralleling recent expansion of production, foods departments of Corn Belt universities, along with other agencies, exert themselves to introduce or expand soybean food uses. Cooked as a green vegetable, only a few varieties prove pleasing in both appearance and palatability.

Soybean flour, ground in fifteen different mills, serves many persons better than wheat flour. A few bakers use up to 15 per cent with wheat flour for ordinary baking uses. Sausage makers, at times, put to 50 per cent soybean flour in part of their product. Soy sprouts of about two inches receive praise as a winter vegetable. Duluth confectionery counters display "Salted Soys" alongside altogether exotic nuts.

Dozens of food preparations, packaged

in twenty plants and now used on a small scale, collectively hold promise for the future. Recipes for preparing soybean "milk" circulate widely; estimates suggest cost so low that an acre of beans may produce ten times the food value possible through pasturing dairy cows.

Soybeans, if constituting more than 10 per cent of total feed of fattening hogs, result in soft pork; some producers remedy this by feeding soybeans heavily only in the growth period and few or none in the period of finishing for market; feeding soybean oil meal results in firm pork. More than 50 per cent soybean meal in dairy ration adversely affects butter consistency. Certain tests show cooked beans superior to tankage and bean meal to linseed meal. Cottonseed meal produces more milk but soybean meal use results in more butter.

Nearly all kinds of livestock relish soybean hay. In feeding value it practically duplicates alfalfa; in some instances it costs more to produce but beans readily make an emergency hay crop after perennials winter-kill.

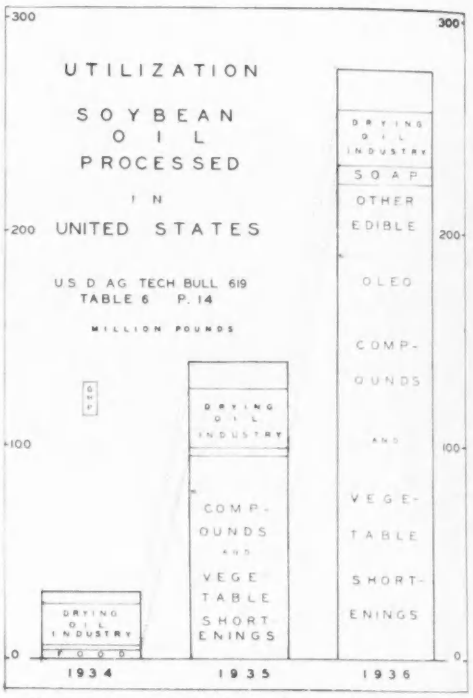

FIGURE 8.—Increasing soybean oil production. Note the expanding food use—chiefly compounds and vegetable shortenings—of the processed oil.

INDUSTRIAL USES OF SOYBEAN OIL AND RESIDUE

Though generally profitable for direct food and feed uses, soybeans for those purposes expand into such highly competitive markets that more profit seems likely through their utilization as factory raw material. Twelve states coöperating with the federal government seek, through the Urbana, Illinois, regional industrial products laboratory, staffed by forty men, to discover improved means of factory processing.

Graphs of oil mill distribution (Figure 7) and increasing production of oil (Figure 8) indicate an expanding market. Beans vary from 12 to 26 per cent in oil and processors prefer yellowish beans of high oil content. A few years since, paint and varnish manufacture used most oil. Chicago "Century of Progress" buildings, some University of Illinois building interiors, and structures of one in ten Illinois farmers carry paint partly from soybeans. Recently, however, compounds and vegetable shortenings lead in soy oil consumption.

Linoleum and oilcloth require considerable oil; printers' ink, oleomargarine, soap-making, foundry cores, and numerous miscellaneous products make lesser demands.

An oilmill of east central Illinois illustrates recent developments. Its six expellers remove oil from 4,000 bushels of beans per day. Work started in October, 1937, at a rate of 1,200,000 bushels yearly. Storage bins hold but one-fourth that amount but readily replenish supplies from a convenient

FIGURE 9.—Mill for removal of oil from Corn Belt soybeans; the processing plant serves an area tributary to Champaign, Illinois, and ships the oil to Chicago factory area.

radius, the plant lying within a heavy producing area. Removed at intervals from the accumulations in two storage tanks, the oil moves northward to Chicago factory area in tank cars. The mill employs around twenty-four workmen in three shifts. One fire temporarily halted operations; nevertheless, the plant rates as a much less hazardous place to work than an "extraction" type plant using high-grade gasoline or other highly explosive solvent.

Plastics, 80 per cent soybean protein, seem an outlet more promising for soybean growers than feeds. Selection and breeding may give manufacturers a more desirable type of raw material; soybean analysis already shows a range from 28 to 56 per cent protein. Actual utilization choice of soybean use ranges from "hay to hairpins."

Paper sizing and coating and wall paper adhesive of soybean casein already enter our markets in quantity. Lauxein, soybean glue, unified fir plywood at a rate of 58,000,000 square feet monthly as early as 1936. Casein also forms a base for water paint and has made an artificial wool; stems of the soybean plant may enter into fabrication of rayon.

In automobile manufacture soybean plastic forms up to twenty different parts including window frames; though costing more than steel the plastic makes for lesser total cost and does not corrode. Makers talk of dashboards and even entire bodies of the synthetic material; indications point towards probable wider expansion in use of soybeans in automobiles and in numerous other types of manufactured goods.

BOOK REVIEWS

VAN VALKENBURG, SAMUEL. *Elements of Political Geography*. 401 pp. Published by Prentice-Hall, Inc., New York, 1939.

In the last few years there has been a flood of books dealing with regional and economic geography, so that the reviewer is glad to see some geographers turning to a much less cultivated section on the borders of geography and history. Dr. Van Valkenburg's book on Political Geography partakes somewhat of the character of Fawcett's recent book as well as of Bowman's "New World," but while shorter, it is probably more comprehensive than either. His training in European universities has given him a fresh point of view which his long experience in America enables him to turn directly to our benefit.

The book consists of seven parts, of which the physical and economic elements are necessarily not very different from those put forward by Semple and others. In his first chapter he elaborates the idea of nations belonging to the different *stages of evolution* (young, old, etc.) made familiar by W. M. Davis in regard to landscape. J. H. Rose and many others, including the reviewer, have studied the usual sequence exhibited in the evolution of a nation, while Moeller-Bruck (like Van Valkenburg) feels that *old* nations cling to possessions while *young* nations are alert and bent on triumph. Of course Davis's great contribution was to show a *genetic* relationship between the various stages. One hopes that the author will expand his interesting suggestion to show how and why nations pass through the stages of youth, maturity, and old age.

The author adopts the useful technique of illustrating his general thesis by special application to one country. He chooses France as his type nation, and this is considered in sixty pages, before he discusses political aspects affecting the world as a whole. Charts are given dealing with birthrates, cephalic indices, languages, foreign alliances, etc. France is a nation with huge colonies, but she has no population to spare to colonize them. Her imperialism, directed to a large degree to gain extra manpower, may seem necessary to her; but is not commendable in a progressive world.

The economic sections are in general up to date; though in a map of the coal resources, it is surprising to find the huge Alberta and Tungus fields omitted. The practice of adding figures of production *in place* on the map is to be commended. U.S.S.R. is not perhaps given the very important economic position which seems to be hers in view of the recent discoveries of coal and metals. Her remarkable exploitation of cold regions might have been described. One of the most interesting tables records the order of importance of the nations in regard to many vital world staples. Of these U.S.A. is predominant in ten, the British Empire in ten, U.S.S.R. in seven, and Germany in three. The implications, if a struggle of the Democracies against Fascism should arise, are obvious.

An interesting chapter deals with "Human Elements." Van Valkenburg properly distinguishes between Nation and Race, and gives a good deal of attention to the Jews. In Vienna the latter formed about 10 per cent of the population, but may have had a 60 per cent share in the economic life. The author states that the German treatment of the Jews "could have been more tactful." A somewhat stronger criticism of the Germans might have been in place.

A map shows that there are no more important compact German groups for Hitler to annex except in the Italian Tyrol. The demand of some nations for more room is examined in detail, and the author concludes that neither Germany nor Italy is overpopulated. Some astonishing figures of future world population are quoted from Hennig. The author very rightly questions these, but he might have quoted more reasonable world estimates. For instance Hennig states that Oceania is able to support 400 millions, though the reviewer's suggestion of sixty or seventy millions is now claimed as too optimistic in Australia. It is stated that the population of Europe has grown from 175 millions to 500 millions, while emigration in that time has removed only 45 millions to other "young" lands. Emigration does not seem to be the cure for over-population, but some reference to the standards of living implied is desirable.

Interesting chapters near the end of this stimulating book deal with Colonies and "The Future of the World." The author rightly points out that neither the weakness of the League of Nations nor the unfortunate results of the Versailles Treaty were so important in causing the present evil condition of Europe as the lack of good will and of time afforded for the necessary period of readjustment. The conflict of capitalism versus socialism is not raised in the book. It is so fundamental in politics that a brief reference would have been in place.

The reviewer appreciates the space given to the numerous maps, but some of them seem to be unduly simple. For instance, a little cross-ruling in the maps discussing Adrianople, Maastricht, Lake Lucerne, and Lake Constance would have brought out the desired features much more clearly. A bibliography of nine pages at the end of the book deals with the chief cognate references.

GRIFFITH TAYLOR

SCHAFER, JOSEPH. *The Winnebago-Horicon Basin; A Type Study in Western History.* x and 349 pp. Published by State Historical Society of Wisconsin, Madison, 1937.

This book, which forms Volume IV of General Studies in the Wisconsin Domesday Book, published by the State Historical Society of Wisconsin, contains a wealth of valuable material germane to the geographer's study of the region, in that it includes much descriptive, interpretative, and historical matter that the geographer may use both for itself, and as a clue to other material of value in his own studies of adjustments and relationships. It represents a most laudable purpose and enterprise on the part of the Society to preserve to posterity for further research such source data as may prove of significance and to organize and partially explain them before time makes them fade into confusion and obscurity. It constitutes a well-nigh unique attempt to conserve the historical resources of the state. Such attempts should be fostered in every state and every county of the Union. Wisconsin is fortunate, as it is in many other respects, that it has an Historical Society with such broad vision.

W. ELMER EKBLAW

SMITH, J. RUSSELL. *Men and Resources; A Study of North America and Its Place in World Geography.* xiii and 729 pp. Published by Harcourt, Brace and Company, New York, 1937.

No better book on the geography of North America has appeared than this new and thorough revision of J. Russell Smith's long popular work on our own continent. In the same trenchant style, with the same wealth of fact embodied in essential principles, and from the same attractive approach as in his earlier book, the veteran author presents the relationships of North American folk and their attributes and activities to the land upon which they live, its character and its effects—the relationship of men and resources, of resources and population, of regions within the continent and between world regions. It is a study of geographic relationships upon a regional basis.

Few authors of textbooks are as stimulating as is J. Russell Smith. His point of view is fresh and generally new; the material he presents is original and up-to-date; his epigrammatic style holds the attention and interest of the pupil; there is little, if anything, dull or trite anywhere in the whole volume of about seven hundred pages.

There are few errors of fact, few misleading interpretations. J. Russell Smith is no more infallible than any other reputable author, but he does succeed admirably in clarity of expression, in conviction of sincerity, and achievement of sustained interest, without sacrificing authenticity, good balance, sound pedagogy—for he is an inspiring teacher as he is an interesting writer. The reviewer feels that perhaps in places there is over-zealousness in advocacy of conservation, undue faith in some panaceas proposed, but he realizes that they arise from the author's intense desire to inculcate among Americans a deep and abiding sense of national thrift and to promote a wise program of utilization of America's resources.

The illustrations are clear and meaningful. The type is one of the easiest fonts to read. The paper is soft-toned and free from glare. The binding is firm, yet flexible. The questions at the end of every chapter are intriguing and challenging. It is an excellent textbook—in subject matter, in selection and organization of that matter, in pedagogical approach and method, in material form. No teacher will make a mistake in adopting it. It is simple enough for High School, comprehensive enough for College.

W. ELMER EKBLAW

MORSE, JAMES KING. *Jedidiah Morse; A Champion of New England Orthodoxy.* ix and 180 pp. Published by Columbia University Press, New York, 1939. Price $2.50.

No sound interpretation of New England economic, social, or political life is possible without due consideration of the religious element in the activities of the people from the time of settlement to the present day. It is because it throws light upon a critical period in New England's history, more than three decades of development, important from every point of view—social, historical, geographical—that this story of the life and times of Jedidiah Morse is important.

There is little of direct geographic significance in the book, little that has interpretative value, except the struggle between strict orthodoxy and growing liberalism in many parts of New England; but it is an excellent discussion of that bitter struggle, written in interesting style. It holds the attention of even the layman.

W. ELMER EKBLAW

ALIHAN, MILLA AÏSSA. *Social Ecology.* xiii and 267 pp. Published by Columbia University Press, New York, 1938. Price $2.75.

The chief value to the geographer of this book upon social ecology would seem to be the elucidation of some of the terminology and the explanation of some of the concepts which the sociologists of the ecological school are borrowing from the field of biologists and attempting to employ in the interpretation of certain cultural aspects of society, particularly the organization and function of social groups as conditioned by the environment in which they develop.

Apparently there is considerable confusion and controversy as to the inherent meaning of ecology when applied to the social group—whether it shall be confined to the attributes of the group as biologic organisms, or expanded to include the cultural attributes which apparently fall within the field of economics. Much of the book constitutes a critique of publications that have appeared from time to time, like Park's, Hurd's, McKenzie's, Wirth's, and others, and that deal with ecological aspects of sociology, but there are also a few passing references to the work of such well known ecologists among biologists as C. C. Adams (in the Bibliography he is listed as G. C. Adams), F. E. Clements, W. C. Allee, and Eugenius Warming.

In another sense the book is a justification of the social ecologists, "translation of biological concepts to cover social aspects, and identifying biological with sociological principles of cycles," to the end that the social group shall be comprehended as "an organismic unity within which social processes happen."

W. ELMER EKBLAW

BRANDT, KARL. *The German Fat Plan and Its Economic Setting*. xii and 344 pp. Published by Food Research Institute, Stanford University, California, 1938. Price $3.00.

Only recently, that is, within the last half century, perhaps within the last decade or two, has the importance of fats not only in the human dietary but in the economic structure of the nations, been adequately recognized. The competition among the several kinds and sources of fats, and the raw materials from which they are derived, has not long been recognized as one of the most important and disturbing factors in the field of international affairs and diplomacy. The nations of the world had not appreciated the significance of the fat factor until the German fat control plan was made the capstone of the whole regulated economic structure of commodity price control; when an entire nation, strictly regimented in every aspect of its social and political life, thus made the fat-control factor the very keystone of their supporting economic foundation, the economists of the world were brought face to face with the reality of the fat-factor, and the conclusion that intensive study of every facet of the problem had become imperative. Since 1928 the Food Research Institute of Stanford University has given particular attention to the matter of fats and oils, and has published a series of papers in which this book is the sixth, and, to date, the last. The series includes:

No. 1. The Fats and Oils: A General View.

No. 2. Copra and Coconut Oil.

No. 3. Inedible Animal Fats in the United States.

No. 4. Margarine as a Butter Substitute.

No. 5. The American Vegetable-Shortening Industry; Its Origin and Development.

No. 6. The German Fat Plan and Its Economic Setting.

The author of this sixth contribution to the series is fully competent to treat authoritatively the subject with which the book is concerned. Before becoming Economist and Professor of Agricultural Economics in the Food Research Institute, he was *Ordentlicher Professor, Landwirtschaftliche Hochschule*, and Director of the *Institut für Landwirtschaftliche Marktforschung*, Berlin. It was he who first pointed out in two articles in a German economic journal, "*Der deutsche Volkswirt*" the interlocking relationships between the various kinds of fats, and other agricultural commodities, and their important implications for the dairy industry, which was even then beginning to feel the effects of the "going without butter to buy cannon" policy of the militant dictatorship of the Reich. Soon after that time the dairy and fat expert of the *Reichs und Preussisches Ministerium fur Ernährung* and *Landwirtschaft, Ministerialrat* Dr. Wegener, after surveying the world situation in competition for fats and the raw materials from which fats are processed, issued the statement upon which the fat-control problem was based, as follows: "In spite of this situation, until 1933 we in Germany were exclusively concerned with dairy economics as such, with reference to milk, butter, and cheese prices which in turn were influenced by the low world prices and from which we tried to sever the domestic production by butter and cheese tariffs or through import quotas. But after having discovered for the first time the coherence between dairy economics and the fat economy, we began to tackle the problem at its root."

The German national fat-control plan is still somewhat in the stage of an experiment, but certain it is that Germany has more definite knowledge of the needs for fats, the supplies of fats available, and such other pertinent facts, and a keener appreciation of the problems involved in providing the nation with its necessary hydrocarbons than have most of the other nations. The author of this book reveals in its pages some of the intricacies and complexities of the international fat situation, something of the magnitude of the fat industries and the other industries dependent upon them, and something of the relative significance of the fat problem as compared with the problems associated with textiles, metals, munitions, and the other many critical elements in the welfare of the nations, and their political strategy. Reading between the lines, the historian, the geographer, and the economist can easily discern the manifold influences at work internationally as well as nationally, the network of special and general interests with which great corporations in trade and finance, great statesmen are concerned. The great Unie-Lever Trust and Hold-

ing Corporation, with its offices in London, has the reputation of being one of the most solidly built and best-managed international combines in the great world of trade, but undoubtedly the political ramifications of its immense financial web can only be conjectured. There is food for deep thought in even this brief review of the power of a gigantic trust in one of the world necessities of industry and life.

The geographic relationships of fat-production, whether the sources of the fat be agriculture, fishing, or manufacturing; of fat-distribution, from all points of view of production and consumption; and of fat-consumption and utilization, among peoples of all ethnic stocks, of all cultural stages, form an inviting field for further research, a field to which this book merely opens the gate, without any attempt to enter. The book is more valuable to the geographer in its incentive to such research, than from the strictly geographic facts it presents, but taken in connection with the other five volumes in the series, it does have a place on the economic geographer's shelves.

W. ELMER EKBLAW

BOSMAN, GEORGE. *The Industrialization of South Africa.* viii and 248 pp., and illustrations. Published by Firma G. W. Den Boer, Middelburg, Rotterdam, 1938.

An increasing amount of good geographic literature is coming to America out of South Africa these days, and Americans in general are becoming better acquainted through their reading with this fast-developing area, with its distinctive problems, its undetermined potentialities, its unappraised and, in a measure, unappreciated, position in world affairs. Every new book that appears, whether it be general, or on some specialized aspect of South Africa's progress, is of value, for few indeed are they who have the opportunity to travel so far to study the region first-hand.

The "Industrialization of South Africa" is one such specialized book which presents a phase of the region's activity about which all too little has been written, all too little known. Written by one who knows whereof he speaks, the book bears authoritative assurance that the prospect it outlines, the achievements it relates, are not based upon mere conjecture, or wishful thinking, but upon sound fact, logical deduction, and reasonable interpretation. To the American geographer—student or teacher—the book affords a most welcome addition to the meager references now available in his library.

Chapter I is devoted to the discussion of the whole economic development of South Africa. The following three chapters, II, III, IV, are concerned with agriculture, fishing, and mining respectively. Chapters V, VI and VII deal in succession with industrialization and labor, the present industrial position, and the industrial future of the region. A well selected bibliography and a rather inadequate map complete the book.

The author's summary is, in his own words, "that South Africa will chiefly have to encourage and develop:

(a) industries entirely or largely utilizing local raw materials and mainly catering for internal demand;

(b) industries utilizing local raw materials and dependent not only upon home markets but also upon foreign demand;

(c) such industries as are essential to industrial expansion in particular and economic development generally;

(d) industries requiring relatively small capital investment; and

(e) such miscellaneous industries (not included in the above categories) as may become firmly established without undue protection."

He concludes with the statement that "South Africa's industrial future is naturally limited on the one hand, but undoubtedly also subject to vast radical changes and comparatively large expansion on the other hand, which can only be achieved with the necessary capital and initiative, by accepting the new forms of social and economic organization, by attempting to realize those ideals with which such forms are associated and by guiding them so as to become mutually serviceable and not mutually destructive. It therefore needs to construct such a framework of law, custom, institutions and planned guidance and direction, that the thrust of individual effort and ambition can only operate to the general advantage."

W. ELMER EKBLAW